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VISCOSITY AND ELECTRICAL RESISTIVITY AND THEIR BEARING ON THE NATURE OF GLASS*

By Nelson W. Taylor

Abstract

The mechanisms of viscous flow and of electrolytic conduction in liquids have been examined to show the significance of the activation energy which is evaluated from the temperature coefficients of viscosity and electrical resistivity. It is shown that the high numerical values characteristic of silicate glasses arise from the ionic character of the liquid, the small coördination number (4) for silicon, and the high electric charge on the ions (Si, 4; O, 2; etc.). Below the softening range, a glass is not necessarily stabilized (*i.e.*, in equilibrium with respect to molecular association or dissociation processes) and its properties depend on its history, mechanical, thermal, etc. In stabilized glasses, the activation energies for viscosity and electric resistivity rise continually with falling temperatures, showing no maximum, in contrast to the views of Preston and Seddon.

The oxygen to silicon ratio has a dominating rôle in the structure of silicate crystals, as shown by W. L. Bragg. Similar concepts are applied to glass, and it is shown that the Preston-Seddon proposal of definite compounds in soda-silica glasses may be replaced by an alternate explanation.

The quantity, β, in the equation, $\eta = ar^{\beta}$, which relates viscosity to resistivity, has a value of 4 to 6 for certain soda-containing glasses. The suggestion is made that viscous shear requires the breaking of four to six times as many sodium-oxygen bonds as does electrical conduction.

Finally, an internal energy-temperature curve, based on specific-heat data for fused silica, has been constructed. The curve shows a steady rise with increasing temperature. It is typical of several glasses.

I. Introduction

A glass may be defined as a supercooled liquid so viscous that its properties depend upon its history.

Preston and Seddon[1] have made an interesting attempt to construct an "ideal *internal energy* curve" which they believe to be characteristic of all glasses. The curve is based mainly on two properties, viscosity and electric conductivity. Temperature coefficients of these properties are plotted for small temperature intervals over the entire observed range. Inasmuch as viscosity, η, and electric resistivity, r, are rate phenomena, "*activation energy*" describes the energy term, E_η or E_r, derived from a plot of log η or log r *vs.* $1/T$, where T is the absolute temperature. Thus,

$$E_\eta = \frac{2.3\,R\,\log \eta_1/\eta_2}{1/T_1 - 1/T_2} \text{ and } E_r = \frac{2.3\,R\,\log r_1/r_2}{1/T_1 - 1/T_2}.$$

R = gas constant, 1.998 cal./Avogadro number (6.06×10^{23}) of elementary processes.

Quoting Frenkel,[2] Preston and Seddon correctly identify the terms, E_η and E_r, as measuring "the heights of the potential barrier" around the equilibrium position of the atoms in the glass. Later they drop this interpretation and use the term, "internal energy," which has an entirely different and restricted meaning, being really related to the curve of heat capacity *vs.* temperature. Preston and Seddon do not get into difficulties until they attempt to extrapolate their curve to absolute zero, when they assume without sufficient justification that "internal energy" will drop to zero.

The significance of the real activation energy for viscous flow and for electric conduction will be discussed, and an attempt will be made to construct from specific-heat data a typical internal-energy curve for a glass.

II. Stabilized and Nonstabilized Glasses

Preston and Seddon's "internal-energy" curve shows a maximum at or very near the softening point. Below this region, the glass is not in a state of equilibrium; its properties are changing with time. In 1933, Lillie[3] discussed this problem and showed that the viscosity of a newly

*Presented at the Glass Division Autumn Meeting, State College, Pa., September 10, 1937, under the title "Developments in the Concepts of the Constitution of Glass." Received September 23, 1937.

[1] E. Preston and E. Seddon, "Temperature-Property Relationships: Their Bearing on the Constitution of Glass," *Jour. Soc. Glass Tech.*, **21**, 123–54 (1937).

[2] J. Frenkel, "Heat Motion of Solid and Liquid Bodies," *Z. Physik*, **35**, 660–67 (1926).

[3] H. R. Lillie, "Viscosity-Time-Temperature Relations in Glass at Annealing Temperatures," *Jour. Amer. Ceram. Soc.*, **16** [12] 619–31 (1933).

drawn fiber changes steadily with time of heat treatment until a finite equilibrium viscosity is reached. This limit is approachable from either side, depending on previous heat treatment of the sample. Lillie reviewed his 1931 work[4] and showed the discrepancy between his old and his new (equilibrium values. Figure 10 (p. 627)[4] is a plot of $\Delta \log_{10}\eta / \Delta(1/T)$ *vs.* t°C for the new and the old data. The maximum in the curve for the new data no longer appears at 600°C (or 873°K), the approximate softening point, as Preston and Seddon have shown it in Fig. 4 (p. 129).[1] By using "equilibrium" viscosity data "the curve is quite smooth over its whole length until a temperature somewhat below 500°C is reached." The softening point therefore loses its significance. Describing the curve below 500°C, Lillie says, "at this point a change in the form of the curve takes place, indicated by the last four points."

These "last four points" do not represent equilibrium values, but they show that the length of time required to reach equilibrium at these low temperatures is in excess of the time allotted for the measurement. In other words, by allowing longer times for each viscosity measurement, the original 1931 maximum was shifted to lower temperatures, and if still longer times were taken, it would be possible to get equilibrium values of the viscosity at still lower temperatures. Of course, owing to the rigidity of the glass, these times become excessively long, of the order of days or months or years, as the temperature is lowered. In fact, Taylor, McNamara, and Sherman[5] have shown that when a glass fiber is under longitudinal tension the equilibrium rate of flow is not reached until the delayed elastic stretch is complete and that the time required for 99% of this delayed elastic elongation increases exponentially as the temperature is lowered, being 800 minutes at 475° and about 10^{30} years at room temperature for a glass of practically the same composition as that used by Lillie (for his No. 1 glass).[3] Taylor, McNamara, and Sherman found in the viscosity range 10^{12} to 10^{15} poises (mean temperature 500°C) that their E_η = 140,000 calories, which is considerably in excess of Preston and Seddon's estimate of 105,000 at this temperature (estimated from Preston and Seddon's curve, Fig. 7).[1]

In further discussion of Lillie's Fig. 10, he states, "it is felt that if true equilibrium were attained, the values of the slope should continue on the upper dotted line." This statement harmonizes with the belief of the writer.

The hump or maximum in the curve as observed may perhaps be explained more simply through an analogy; *e.g.*, consider a chemical compound, such as NH_3, which dissociates on heating according to the equation,

$$2NH_3 = N_2 + 3H_2.$$

Because heat favors the dissociation, it would appear that the formation of NH_3 from the N_2 and H_2 would be favored by making the temperature as low as possible. This is what thermodynamics shows; in fact, the mol fraction of NH_3 in the equilibrium mixture does increase as the temperature is lowered. On the other hand, the rate of formation of NH_3 becomes progressively less as the temperature is lowered until it is almost negligible (see Fig. 1).

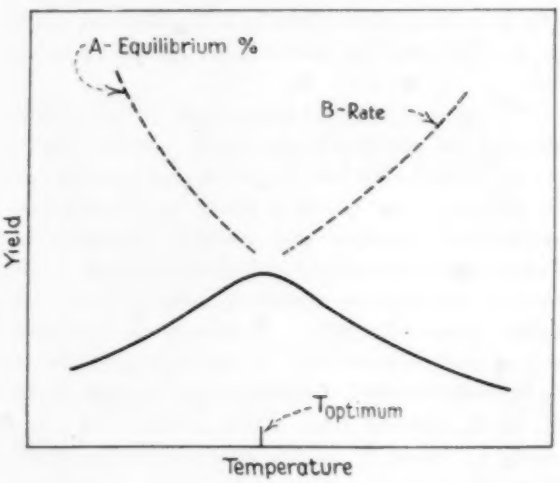

FIG. 1.

It is evident that for practical results, that is, to get the maximum yield in a given time, one must choose the temperature marked T_{optimum} where the combined curves show a hump or maximum. This is a rather crude analogy to the glass case, but the fundamental factors of rate and equilibrium are operating in both cases.

Littleton[6] has introduced the concept of a

[4] H. R. Lillie, "Viscosity of Glass between Strain Point and Melting Temperature," *Jour. Amer. Ceram. Soc.*, **14** [7] 502–11 (1931).

[5] N. W. Taylor, E. P. McNamara, and J. Sherman, "Study of the Elastico-Viscous Properties of a Soda-Lime-Silica Glass at Temperatures near the 'Transformation Point,'" *Jour. Soc. Glass Tech.*, **21**, 61–81 (1937).

[6] J. T. Littleton, "Critical Temperatures in Silicate Glasses," *Ind. Eng. Chem.*, **25**, 748–54 (1933); *Ceram. Abs.*, **12** [10–11] 360 (1933).

"stabilized" glass as one which has been held sufficiently long at a given temperature to assume the constant properties characteristic of that temperature. As to viscosity, Littleton states, "viscosity changes with time just as do the other physical properties of glass. Apparent discontinuities are due to insufficient time for stabilization."

In considering electrical conductivity, Littleton discussed the work of Fulda, which has been used by Preston and Seddon to fix their "internal energy" curve. Fulda himself observed drifts in conductivity with time in some cases. Littleton concluded that "there is no sudden discontinuity in the electrical conductivity of annealed glass, but a slow change, the rate of which probably depends upon the viscosity of the glass. The change lags behind the temperature for the more rapid temperature changes, and when it does begin, it operates so as to give the appearance of a critical temperature point." In a later paper, Littleton and Wetmore[7] have presented resistance

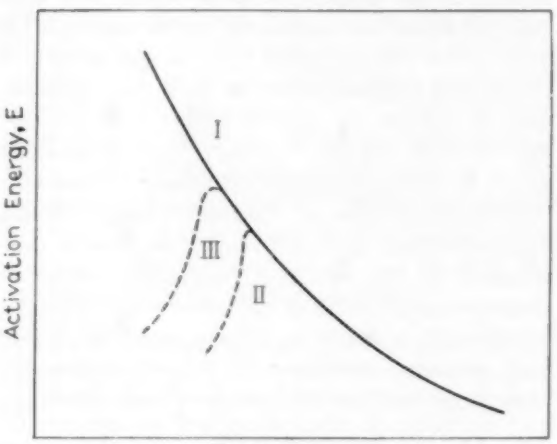

FIG. 2.

data on a soda-potash-lead glass in the chilled, annealed, and stabilized (equilibrium) states. In the latter case, no bending of the log R *vs.* $1/T$ curve occurred at the "transformation point," and the slope of the line was steeper than the corresponding slope of the chilled or annealed sample. This means that the derived "internal energy" for the stabilized glass would lie well above the left-hand portion of Preston and Seddon's curve in their Fig. 7, and, therefore, would cause their maximum to disappear.

On the basis of these facts, it would appear that the activation-energy curve, which Preston and Seddon call the "internal-energy" curve, for a stabilized glass would be approximately as shown by the continuous line in Fig. 2, without any maximum such as is shown on the broken lines.

III. Molecular Forces in Liquids

To get some idea of the factors determining the magnitude of the energy of activation for the viscous-flow process, some data are examined on the quantity, B, calculated from the Guzman[8] equation, $\eta = Ae^{B/RT}$ by Ward.[9] These values are given in kilocalories per gram atom or gram molecule. Typical ionic liquids without directional forces are NaCl, NaBr, and KCl. For these, B is 9.10, 8.00, and 7.40, respectively. These decrease with increasing size of ion, *i.e.*, with increasing distance between positive and negative centers of attraction. As an example of an ionic liquid with directional forces between the atoms, B_2O_3 is chosen. Ward states that in boric oxide there is a highly polarized ionic bond. B values are 75.0 and 21.7 for the low and high temperature ranges (below 400° and above 725°). The large values for B_2O_3 are to be ascribed in part to the higher valence of the component ions. The change with temperature is ascribed by Ward and by Bernal[10] to changes in coördination, *i.e.*, in the number of nearest and next nearest neighbors about a given atom. Coming back for the moment to simpler cases, the nonpolar molecular liquids, such as argon and nitrogen, have very small values of B, 0.524 and 0.468, respectively. Dipolar molecular liquids like ethyl bromide or ethyl iodide show B to be equal to 1.12 and 1.25. Molecular liquids with hydroxyl bonds, such as H_2O and C_2H_5OH, have the somewhat larger values of 3.05 and 2.34. In typical "molecular" liquids, there are rather strong forces within the molecule but comparatively weak forces acting between molecules, while in ionic liquids the whole structure is continuous in the sense that the ions build up a sort of lattice of alternate charges with no regions of distinct weakness. When vis-

[7] J. T. Littleton and W. L. Wetmore, "The Electrical Conductivity of Glass in the Annealing Zone as a Function of Time and Temperature," *Jour. Amer. Ceram. Soc.*, **19** [9] 243–45 (1936).

[8] J. de Guzman, "Relation between Fluidity and Heat of Fusion," *Anales soc. espan. fis. quim.*, **11**, 353 (1913).

[9] A. G. Ward, "Viscosity of Pure Liquids," *Trans. Faraday Soc.*, **33**, 88–97 (1937).

[10] J. D. Bernal, "An Attempt at a Molecular Theory of Liquid Structure," *ibid.*, **33**, 27–40 (1937).

cous shear occurs, the process is not so localized as in the case of "molecular" liquids, and the activation energy should be large. The configurational change probably involves a partial breakdown and rebuilding of the coördination of an ion by ions of opposite polarity. Ward states in summary that the magnitude of B depends on the coördination and on the interionic, interatomic, or intermolecular forces.

Bernal goes into this problem in more detail. He contrasts a crystal, where the coördination about any given atom is constant, with a liquid having points of abnormal coördination; *e.g.*, 7 or 5, instead of the usual 6 of a hexagonal close-packing.

> "A liquid might be imagined to be produced from a solid by the removal of certain atoms and the subsequent rearrangement of the remaining atoms to fill as nearly as possible the gaps those left."

Eyring[11] has pointed out that the fraction of space occupied by these gaps or holes will be about the same as that occupied by the molecules of vapor in equilibrium with the liquid. This means that, other things being equal, a liquid of low-vapor pressure will have few "holes" and probably a high viscosity temperature coefficient. Bernal states that the existence of directed forces, such as highly polarized ionic bonds, tends in general to lower the effective coördination of the liquid.

> "This lower coördination will affect both the thermal properties and the viscosity of the liquid. Change of configuration will here be associated with greater energy and the result will be a much larger configurational specific heat and correspondingly larger viscosity. Corresponding to this, there will also be a far greater tendency to form glasses—a glass being defined as a supercooled liquid in which the viscosity has become so high that the configuration remains fixed at a state not corresponding to the equilibrium configuration but one determined by the heat treatment and the time elapsed."

Bernal shows that the molecular structure of a simple liquid is described by three variables, (1) the mean distance of closest approach of molecules, (2) the number of close neighbors of any molecule, and (3) the irregularity of the distribution.

With these general comments on the liquid state as a background, the quantity, B, of the equation $\eta = Ae^{B/RT}$, or the quantity, E_η, which is used by Preston and Seddon,[1] represents the energy which must be supplied to bring about a configurational change under the shearing stress. It is not the net difference between two states of minimum potential energy but rather the height of a potential barrier which must be crossed in the destruction of the original molecular configuration. For ionic liquids, B will be large when the valence is large, when there are strong directional forces, and when the coördination number is small. Thus, in fused silica, a 4-valent silicon atom is surrounded on the average only by 4 oxygen neighbors in a continuous 3-dimensional network. B or E_η is approximately 190 kilocalories for fused silica in the viscosity range 10^{10} to 10^{12} poises.[12] The introduction of Na_2O into this glass provides regions of relative weakness, owing to the single positive charge on the Na^+ ion and the correspondingly weak Na–O bond. This reduces B approximately to 150 kilocalories for Na_2O–SiO_2 glasses in the viscosity range 10^{11} to 10^{15} poises.[13] It may be somewhat less for the range 10^{10} to 10^{12}. The influence of Pb^{++} ion in lead-silica glasses is shown by an average value of about 150 kilocalories, based on viscosities[14] in the range 10^{11} to 10^{15}. The rôle of other ions is not known in detail, but evidence exists to show that substitution of an ion by one of higher valence, *e.g.*, Na^+ by Ca^{++} or Ca^{++} by Al^{+++}, leads to an increase in the temperature coefficient of viscosity. The interpretation of viscosity changes arising from substitution of one ion by another is complicated by the fact that frequently volume or density changes occur at the same time. Viscosity is extremely sensitive to volume, as shown by the high pressure coefficient.[15] Neglect of this volume factor has been the source of much confusion.

IV. Oxygen-Silicon Ratio and Its Bearing on the Structure of Glasses

Preston and Seddon[1] have made a special study of soda-silica glasses, using the 1000° to 1500° viscosity data of Heidtkamp and Endell.[16]

[11] H. Eyring, "Viscosity, Plasticity, and Diffusion as Examples of Absolute Reaction Rates," *Jour. Chem. Phys.*, **4**, 283 (1936).

[12] H. P. Volarovitch and A. A. Leontieva, "Determining Viscosity of Quartz Glass within the Softening Range," *Jour. Soc. Glass Tech.*, **20**, 139–43 (1936); *Ceram. Abs.*, **16** [1] 11 (1937).

[13] N.W. Taylor and P. S. Dear, "Elastic and Viscous Properties of Several Soda-Silica Glasses in the Annealing Range of Temperature," *Jour. Amer. Ceram. Soc.*, **20** [9] 296–304 (1937).

[14] G. J. Bair, "Constitution of Lead Oxide-Silica Glasses: II," *ibid.*, **19** [12] 347–58 (1936).

[15] R. B. Dow, "Note on Viscosity as Function of Volume and Temperature of Oils," *Physics*, **6**, 270–72 (1935).

[16] G. Heidtkamp and K. Endell, "Relation of Density and Viscosity to Temperature in System Na_2O–SiO_2," *Glastech. Ber.*, **14**, 89 (1936); *Ceram. Abs.*, **15** [9] 272 (1936).

Their Fig. 14 is a plot of E_η *vs.* % Na_2O. The curve shows inflections at 34 and 51% Na_2O, which correspond to the compounds $Na_2O{\cdot}2SiO_2$ and $Na_2O{\cdot}SiO_2$, respectively, and the authors infer that these compounds must be present in the glass. The writer does not wish to become involved in arguments as to the existence or nonexistence of certain compounds in liquid solution. There is, however, one interesting feature of this curve which is worthy of mention. W. L. Bragg[17] has shown that the structure of silicate crystals is largely determined by the ratio, O/Si, where O and Si denote the numbers of atoms of oxygen and silicon, respectively, in the molecule of the compounds. Thus, when O/Si = 4, there are separate SiO_4 groups or tetrahedra not connected except through metallic cations. Olivine ($(Mg,Fe)_2SiO_4$) is such a crystal. When O/Si = 3, the tetrahedra link to form chains as in the pyroxenes $CaMg(SiO_3)_2$.

These metasilicates contain no individual SiO_3 groups, but rather a series of endless linear acid radicals stretch across the crystal structure, bound sidewise by the metal cations. Intermediate between these two O/Si ratios are cases of large Si–O groups, such as Si_2O_7, which exist as distinct entities in the structure, linked only to each other by metal cations. When the ratio, O/Si = 2.5, a sheet structure is formed, which in the simplest and most common form is a hexagonal network "with an appearance like that of a wire netting." The acid radicals are now extended indefinitely in two directions in space.

> "They are infinite sheets, held together by metallic cations placed between them. The hexagonal nature of the sheets confers a hexagonal or pseudohexagonal symmetry on all the minerals, such as talc and mica, in which they are found."

Finally, in SiO_2 itself, with a ratio O/Si = 2, a three-dimensional network is formed, as in quartz, cristobalite, or tridymite.

This concept may be carried over with profit to glass, and some properties of silicate liquids can be explained in part according to these structures which probably exist in glass in an imperfect or distorted form.

Referring again to Fig. 14 of Heidtkamp and Endell,[16] it is seen that the composition $Na_2O{\cdot}2SiO_2$ (O/Si = 2.5) marks the "sheet" structure and, with increasing percentage of Na_2O, the end of 3-dimensional networks; further, the composition $Na_2O{\cdot}SiO_2$ (O/Si = 3) marks the "extended-chain" structure, the end of "sheet" structures, and the beginning of smaller silicate units, such as Si_2O_7. The parallel-energy requirements for viscous flow in these various structures appear obvious.

Most commercial silicate glasses (free of B_2O_3) have an O/Si ratio of about 2.5.

V. Electrical Conduction in Glass and Its Activation Energy

The phenomenon of electrical conduction in ionic conductors, in some respects, is simpler than that of viscosity. Particularly in the lower temperature range, there is abundant evidence that the current is carried largely by a single ion. Thus, in sodium chloride crystals, Phipps and Leslie[18] have shown by transference experiments that the positive ion, sodium, carries practically all the current and, under the influence of the applied electric field, it filters through the negative-ion lattice. At higher temperatures, both ions move and carry current, and the activation energy (computed from the temperature coefficient of conductivity) is roughly doubled. Where the salt has a mixed valence, the ion of lower valence usually carries nearly all of the current unless the temperature is very high. Thus, Tubandt[19] found that in solid $PbCl_2$ only the chloride ion conducts electricity. Passing over to silicate glasses, containing, for example, Na^+, Ca^{++}, and silicate ions, the Na^+ will be expected to carry the major portion of the current, unless the temperature is very high. The following data are taken from Gelhoff and Thomas,[20] who report the temperature at which the conductivity of certain glasses reaches 10^{-8} mhos per centimeter.

$Na_2O{\cdot}MgO{\cdot}6SiO_2$	139°C	$K_2O{\cdot}MgO{\cdot}6SiO_2$	197°C
$Na_2O{\cdot}CaO{\cdot}6SiO_2$	199	$K_2O{\cdot}CaO{\cdot}6SiO_2$	283
$Na_2O{\cdot}BaO{\cdot}6SiO_2$	244	$K_2O{\cdot}BaO{\cdot}6SiO_2$	318

In every case the Na^+ conducts more easily than K^+ ion. The bivalent ions may be regarded as tightening the lattice by virtue of their electric

[17] W. L. Bragg, Atomic Structure of Minerals, Chapt. IX. Cornell Univ. Press, Ithaca, N. Y., 1937.

[18] T. E. Phipps and R. T. Leslie, "Transference Numbers of Ions in Solid Sodium Chloride at High Temperatures," *Jour. Amer. Chem. Soc.*, **50**, 2412–21 (1928).

[19] Tubandt, "Electric Conduction in Solid Crystalline Compounds," *Z. anorg. allgem. Chem.*, **115**, 105 (1921).

[20] G. Gelhoff and M. Thomas, "Physical Properties of Glass in Relation to Its Composition," *Z. tech. Physik*, **6**, 544–54 (1925); *Ceram. Abs.*, **5** [6] 178 (1926). *Cf.* J. T. Littleton and G. Morey, Electrical Properties of Glass. John Wiley & Sons, Inc., New York, 1933.

charge and also by offering physical obstruction to the "filtration" of Na^+ or K^+ through the interstices of the glass structure, for the larger they are the higher is the temperature needed to reach a conductance of 10^{-8} mhos. From crystal data, the ionic radii are Na^+ 0.98, K^+ 1.33, Mg^{++} 0.78, Ca^{++} 1.06, Ba^{++} 1.43Å.

The inference is that the energy term, derived from the temperature coefficient of the electric conductivity, is the critical increment of energy which the conducting ions of a lattice must acquire in order to be free to move under the influence of the applied field. It would appear that the weakest bond, *e.g.*, the Na–O bond, is the most easily broken and that the process is a release of the individual ion rather than the coöperative breakdown of several such bonds with shearing of the whole structure as in viscous flow. Electric conduction appears to be a kind of "filtration" process not involving as general a breakdown of the whole ionic lattice network as does viscous "shear."

VI. Comparison of Energy Requirements for Viscous Flow and Electric Conduction

The two processes of viscous flow and electric conduction appear to be related, as Babcock[21] has demonstrated in the equation, $\eta = ar^{\beta}$, and as Preston and Seddon[1] have shown in their work. Babcock concludes "that the process of conduction is determined chiefly by the motion of the vagabonding ions through the 'liquid' interstices, and the viscosity is determined by a quasi-solid network and its ramifications." His β values range from 2 to 6, although some of the data may be based on nonequilibrium (unstabilized) glasses. Preston and Seddon give $\beta = 5$ and $\beta = 6$ for two soda-silica glasses and $\beta = 4$ for a soda-lime glass. Taylor and Dear[5] give $\beta = 5$ or 6, based on their own viscosity data, and on Seddon, Tippett, and Turner's[22] electric resistivity data on soda-silica glasses.

NOTE: In par. 1, 2nd column, page 304 of the paper by Taylor and Dear, the numbers 18000 cal./mol. and 8 should be changed to 25000 to 30000 cal./mol. and 5 or 6, respectively.

The theoretical evaluation of the energy of activation for either the viscous shear or the electrical conductance process is difficult, because it involves an exact knowledge of all the pertinent ionic distances, force constants, etc. The easier problem of the calculation of a Madelung constant for a perfect crystal of known structure has been carried through only for the simple lattices. A notable effort, however, to work out these energies from first principles has been made by Eyring.[11]

Progress has been greatest in the case of nonpolar molecular liquids. In the case of fused salts and silicate glasses, there is still much to learn. Purely as a rough guess, it may be said that viscous shear in soda-silica glasses involves the "breaking" of 4 to 6 times as many weak bonds as does electrical conduction.

VII. Internal Energy-Temperature Relation for Glass

Lewis and Randall[23] define the internal energy, E, of a substance in terms of its heat capacity at constant volume, C_v. Thus $(\delta E/\delta t)_v = C_v$. Consequently at any temperature, T, the magnitude of the internal energy is given by the relation,

$$E = \int_0^T C_v dT + E_0.$$

Where E_0 = energy at absolute zero.

Without entering into a study of the magnitude of E_0, the quantity may be evaluated $E - E_0$ by plotting C_v *vs.* T and taking the area under the curve. In general, values of C_v are not as readily available as the corresponding values of C_p, the heat capacity at constant pressure. The two quantities are related by the equation,

$$C_v = C_p - \alpha^2 VT/K.$$

Where α = coefficient of thermal expansion.
K = compressibility.
V = molal volume.
T = the absolute temperature.

In the case of glasses or other condensed phases, the third term of this relation is comparatively small and no great error is made in substituting C_p for C_v.

Kelley[24] has made a critical examination of the data on the heat capacity of vitreous silica from room to high temperatures. He gives C_p =

[21] C. L. Babcock, "Viscosity and Electrical Conductivity of Molten Glass," *Jour. Amer. Ceram. Soc.*, **17** [11] 329–42 (1934).

[22] E. Seddon, E. J. Tippett, and W. E. S. Turner, "Electric Conductivity of Sodium Metasilicate-Silica Glasses," *Ger. Soc. Glass Tech.*, **16**, 450–77 (1932); *Ceram. Abs.*, **12** [7] 257 (1933).

[23] G. N. Lewis and M. Randall, Thermodynamics and the Free Energy of Chemical Substances. McGraw-Hill Book Co., New York, 1923.

[24] K. K. Kelley, "High-Temperature Specific Heat Equation for Inorganic Substances," *Bur. Mines Bull.*, No. 371 (1934).

$12.80 + 4.47 \times 10^{-3}T - 3.02 \times 10^{5}T^{-2}$ and states this to be accurate to 2% below 1173°C. Kelley remarks that it is well known from the study of other glasses that the specific heat may be greatly affected by thermal treatment, especially in the temperature range where annealing occurs. Sosman[25] suggests that the more rapidly rising portion of the heat curve of vitreous silica, beginning at about 1300°, may be connected with the beginning of softening of the glass. It is analogous to the much more sharply marked changes in amorphous glycerol[26] at about −100°C and amorphous alcohol [27] at about −180°C.

In a later paper,[28] Kelley tabulates the "best" values for C_p of vitreous silica in the low-temperature range as follows: 10°K, 0.06; 25°K, 0.56; 50°K, 1.63; 100°K, 3.86; 150°K, 5.89; 200°K, 7.75; 298.1°K, 10.60. These values and the earlier equation permit the evaluation of the heat content, Q, above 273.1°K, where Q is defined by the relations,

$$C_p = a + bT - cT^{-2} \text{ and } Q_{T_1}^{T_2} = \left[aT + \frac{bT^2}{2} + cT^{-1}\right]_{T_1}^{T_2}.$$

Kelley finds that Q has values 1130, 2370, 3800, 5320, 8540, 11850, 15390, 18880, and 24600 calories per formula weight at 100, 200, 300, 400, 600, 800, 1000, 1200, and 1500°C, respectively. These are plotted in Fig. 3. It will be seen that these values rise continuously and that there is no minimum or maximum at any intermediate temperature in contrast to the shape of Preston and Seddon's [1] Fig. 15. Similar behavior is shown by orthoclase glass ($KAlSi_3O_8$), by albite glass ($NaAlSi_3O_8$), and by the glasses of the composition $MgSiO_3$, $CaMg(SiO_3)_2$, and $CaAl_2Si_2O_8$.

VIII. Influence of Temperature on Structure of Glass

There is more or less general agreement that a linear log η *vs.* $1/T$ or log r *vs.* $1/T$ relation indicates a constant or fixed molecular structure, subject to changes only in amplitude of motion but not undergoing significant changes in configuration, *i.e.*, in coördination. Relations, such as shown in Fig. 2, curve I, are therefore interpreted in terms of a progressive dissociation or break-up of complex aggregates as the temperature increases. Naturally, the weakest bonds would dissociate first, while the strongest would persist to the highest temperatures. Owing to the random or irregular nature of the network, all intermediate cases are possible so that the curve is

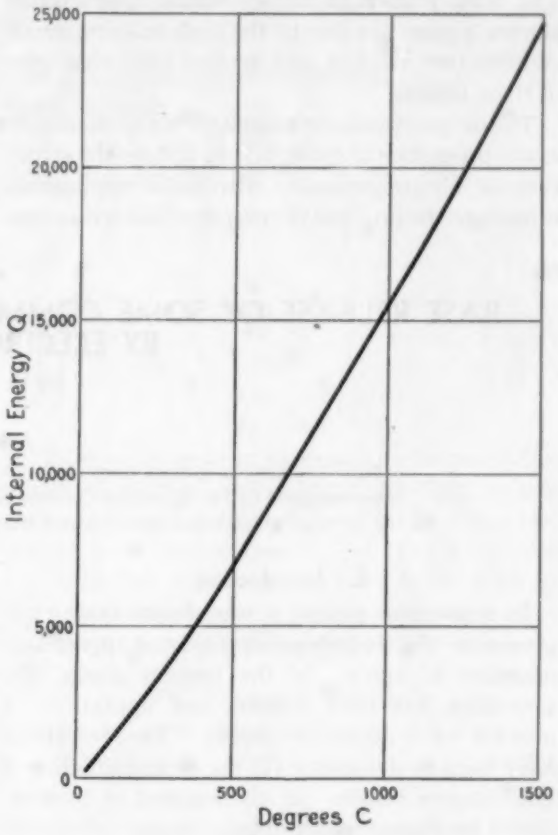

FIG. 3.

continuous. Just as in the cool days of spring great flocks of blackbirds or swallows work their way northward, later to break up into smaller bands and eventually into nesting pairs or free lances during the hot season, and then with the first touch of cooler weather they gather into small groups which unite to form larger and yet larger southbound flocks as autumn chills the air, so can be visualized the progressive dissociation and association of molecular aggregates in silicate liquids with rising and falling temperatures.

IX. Summary

The Preston-Seddon "internal energy"-temperature curve for glass is shown to be open to criticism on several points, *viz.*, (1) below the

[25] R. B. Sosman, The Properties of Silica. The Chemical Catalog Co., Inc., New York, 1927.
[26] G. E. Gibson and W. F. Giaugue, "Third Law of Thermodynamics," *Jour. Amer. Chem. Soc.*, **45**, 93–104 (1923).
[27] Gibson, Parks, and Latimer, "Entropy Changes at Low Temperatures," *ibid.*, **42**, 1542–50 (1920).
[28] K. K. Kelley, "Revision of the Entropies of Inorganic Substances, 1935," *Bur. Mines Bull.*, No. 394 (1936).

softening point the properties were changing with time, *i.e.*, the glasses were not stabilized, and (2) internal energy is related to specific heat, not to viscosity or electric resistivity.

An activation-energy curve for a stabilized glass has been constructed. It rises with falling temperatures and shows no maximum or inflections. The high numerical values which characterize silicate glasses are due to the high valence, small coördination number, and general ionic character of these liquids.

The oxygen to silicon ratio is shown to dominate many properties of glass, just as it does the structure of silicate crystals. Particular application is made to the problem of compounds in soda-silica glasses, and it is concluded that their assumption is unnecessary.

The quantity, β, in the equation, $\eta = ar^{\beta}$, which relates viscosity to resistivity, has a value of 4 to 6 for certain soda-containing glasses. The suggestion is made that viscous shear requires the coöperative break of 4 to 6 times as many weak (Na–O) bonds as does electrical conduction.

An internal energy-temperature curve, based on specific heat data for fused silica, has been constructed. It is typical of several glasses. The curve shows a steady rise with rising temperatures.

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BASE RELEASE OF SOME COMMERCIAL GLASSES AS DETERMINED BY ELECTRODIALYSIS *

By R. M. King

Abstract

Nine commercial glasses were electrodialyzed, and the results were compared with those obtained by the American Ceramic Society No. 1 powder method. Data showing the rates at which bases were released have been included.

I. Introduction

In a previous paper[1] it was shown that when glasses are electrodialyzed they release appreciable amounts of bases. In the present study, the procedure has been refined and applied to a number of commercial glasses. The objectives have been to determine (1) the reproducibility of quantitative results, (2) the amount of base released by glasses which differ in composition, and (3) the rate of base release.

Fundamentally, electrodialysis is electrolysis in which basic ions are removed from solid matter by electrolytic conduction and washed out of the main solution by electroösmosis and a siphoning action. The solution thus removed may be titrated to obtain total bases and may be chemically analyzed to obtain the nature and amount of individual bases present. The theory of electrodialysis has been discussed by Bradfield.[2(a)]

II. Apparatus

A battery of four Bradfield[2(b)] cells was employed in these tests. These cells were connected in series by twos, the two sets in turn were connected in parallel, and 125 volts d.-c. were applied to the terminals. This battery was provided with a water-feeding and leveling device (see Fig. 1).

III. Procedure

Preliminary tests indicated that if the samples were ground and classified so that all passed a 200-mesh screen but were retained on a 325-mesh screen, an inconveniently large sample was necessary to obtain workable amounts of base. But if all were ground to pass a 200-mesh screen and 50% to pass a 325-mesh screen, a one-gram sample sufficed. Inasmuch as most of the tests for any one glass were on the same sample, each general sample was not tested for grain size. Several tests, however, were run on one glass to determine the error due to difference in fineness.

One-gram samples were accurately weighed and thoroughly mixed with one gram of 48-mesh

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* Presented at the Thirty-Ninth Annual Meeting, American Ceramic Society, New York, N. Y., March 23, 1937 (Glass Division). Received March 9, 1937; revised copy received April 10, 1938.

[1] R. M. King, "Mechanics of Enamel Suspension: II, Electrodialysis of Enamels and Glasses," *Jour. Amer. Ceram. Soc.*, **18** [8] 230–33 (1935).

[2] (*a*) R. Bradfield and H. S. Bradfield, "Rôle of Membranes in Electrodialysis," *Jour. Phys. Chem.*, **33** [11] 1724–32 (1929).

[2] (*b*) R. Bradfield, "Simplified Cell for Determining Electrodialyzable Base Content of Soils and Permutits," *Jour. Amer. Soc. Agron.*, **19** [11] 1015 (1927).

"alkali-free" fused alumina grain. This latter prevented "cementing" of the glass. The samples were then placed in the porous Alundum thimbles, which in turn were placed in the glass cells. These cells were filled with water from the siphoning tubes, and the voltage was applied.

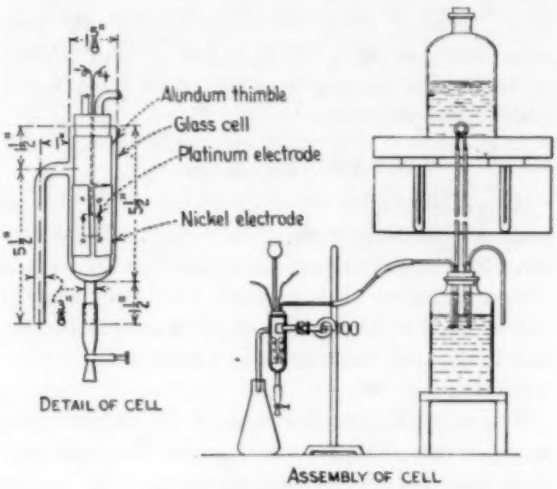

FIG. 1.

Electrodialysis was continued for 9 hours, but fractions were tested every $1^1/_2$ hours. The contents and washings of the outer chamber were removed with the current on and included as a portion of the fraction. An excess of standardized acid (approximately 0.02 *N* HCl) was added to each fraction, which were then brought to a boil, cooled, and titrated with standardized sodium hydroxide of about the same strength as the acid. Phenolphthalein was used as an indicator.

An essential part of this test was to see that all possible alkali was removed from the thimbles. These were electrodialyzed until only 0.1 cc. of 0.02 *N* acid was sufficient to neutralize the alkali obtained from one thimble in $1^1/_2$ hours. Considerable work in an effort to procure blanks led to the conclusion that if this treatment is followed no appreciable error will be introduced.

IV. Glasses Tested

A glass-electrode glass was selected arbitrarily for preliminary studies on influence of grain size.

Other glasses tested include four furnished by the Committee on Durability Tests and four by W. C. Taylor, Corning Glass Works.

The compositions and densities of the glasses are given in Table I.

TABLE I

Glass	SiO_2 (%)	R_2O_3 (%)	Na_2O (%)	K_2O (%)	B_2O_3 (%)	CaO (%)	MgO (%)	PbO (%)	Density
A	81	2	4		13				2.23
B	73	1	17			5	3		2.47
B_1									2.47
B_2									2.47
C	72	1	13			9	5		2.47
D	63	1	7	7				22	2.85
E	35			7				58	4.23
F	60	3	8		29				2.23
EG	72		22			6			2.48

V. Data

The data have been expressed in terms of the weight of sodium oxide released per 7000 square centimeters of surface, calculated by assuming the grains to be cubes (see Table II). Only the values for the 9-hour period have been given in this table, but those for all intervals have been used in plotting the rate curves in Fig. 2.

VI. Discussion of Data

Comparison of these data with the data obtained by Taylor,[3] who used the American Ceramic Society No. 1 powder method, shows that the electrodialysis values are higher than those obtained by any of the three solvents employed, except those on E and F, which were treated with sulfuric acid. This is true for the 4-hour period

TABLE II

		Glass							
		B	B_1*	B_2	C*	D	E	F	EG
Gram/sample		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Area of sample (cm.²)		541	488	488	488	424	285	541	485
Grams Na_2O/7000 cm.²		0.0194	0.0583	0.0418	0.0554	0.0586	0.0614	0.0445	0.1565	0.2064
Av. deviation		.0019	.0019	.0029	.0008	.0022	.0034	.0021	.0117	.0165
Taylor's values (40°C)	H_2SO_4	0.0037	0.0127			0.0077	0.0193	0.1850	0.1690	
	H_2O	.0012	.0088			.0042	.0069	.0015	.0098	
	NaOH	.0027	.0055			.0048	.0041	.0046	.0136	

* Average of three samples.

[3] W. C. Taylor and R. D. Smith, "Solubility Characteristics of Glasses Basically Different in Composition," *Jour. Amer. Ceram. Soc.*, **19** [11] 331–34 (1936).

as well as the 9-hour period. These comparisons were made with Taylor's results at 40°C because there was a temperature rise which was slight for glasses of low base release. This was quite marked and increased decidedly when there was a high base release, such as that for glasses F and EG. No attempt was made to control the temperature, which may account for the high error for glasses F and EG, although a portion of the

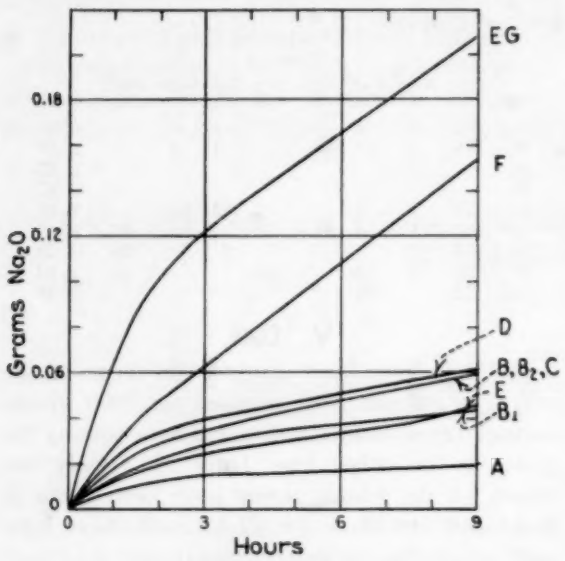

FIG. 2.

error for EG was due to difference in particle size. The value given for this glass represents the average of 12 separately ground samples. The value for glass F is an average result from four samples of the same grain size. Thus with glasses of about the same base release, a 7.5% variation in base release was obtained when there was no variation in grain size, and an 8.0% variation when no effort was made to control grain size. This indicates that with samples of small particle size there is a greater error from the procedure than from the preparation of the sample. The error for the samples of low base release averaged about 6%.

Electrodialysis is a convenient method for obtaining the rate of base release from the same sample. The rates for the glasses tested are indicated by the curves in Fig. 2. For the first three hours, the rate of release was quite rapid, but it became constant during the latter part of the test. The initial high rate was probably due to the more immediate availability of the surface ions as compared with those which were imbedded in the particle of glass.

Because chemical analyses of some glasses were not available, deductions relating to composition are somewhat limited. Bottle glasses, B and B_2, and plate glass C have almost identical release values; B and C are closely related in composition. Glass E, high in lead, has a higher release value than glass D, which is low in lead. Glass A, with high silica, low alkali, and B_2O_3, has a much lower release.

VII. Comments

Although small analytical cells were used in these tests, electrodialysis procedure need not be confined to this design, inasmuch as cells may vary in design and size. It is possible, therefore, to apply this method to large pieces of glass, such as bottles, and to separate both acids and bases from a given substance.

The method described has all the objections of any powder method with the one exception that it does not permit establishing a static equilibrium. Apparently such an equilibrium is established in the No. 1 powder method and this probably, at least partially, accounts for the higher results obtained by electrodialysis. As indicated by the rate curves, a 9-hour period is not required to obtain the base-release characteristics. A 6-hour period should be satisfactory.

VIII. Summary and Conclusions

Base release obtained by electrodialyzing a glass powder was, in most cases, higher than the amount liberated by sulfuric acid, water, and sodium hydroxide when treated according to the No. 1 powder method.

Correlation of results with chemical composition is general. Glass F seems to release a large amount of base; glass A releases little in all cases; all other values fall between these two results.

Error by this method is about twice that of the No. 1 powder method. It has all the objections of the No. 1 powder method, except that it does not permit a static equilibrium and removes the influence of added chemical ions.

Electrodialysis is a convenient method for determining the rate of base release and therefore may simulate weathering.

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COMPARISON OF TENSILE STRENGTHS OF SHEET-IRON GROUND-COAT ENAMEL GLASSES*

By A. I. Andrews and W. W. Coffeen

Abstract

The fiber method developed by Schwalbe, Badger, and Silverman for comparing the tensile strengths of glasses was used to compare the tensile strengths of sheet-iron ground-coat enamel glasses whose feldspar, borax, and quartz contents varied within workable limits. For purposes of comparison, this method uses that value of the unit stress at failure which exists in a fiber whose fractured surface shows a smooth portion constituting 1% of the total cross-section. For the enamels tested, these values of tensile strength ranged from 30.0 to 32.7 kg. per sq. mm. (42,000 to 46,000 lb. per sq. in.). An increase in quartz or feldspar tended to raise the tensile strength slightly, while an increase in borax tended to lower it slightly, although the total variation was small. From these data, it was concluded that insofar as the enamel strength was concerned mechanical failures of the enamel, such as chipping, fishscaling, or crazing, could not be aided by variations of the feldspar, borax, and quartz contents of sheet-iron ground-coat enamel glasses within workable limits.

I. Introduction

The tensile strength of a material is one of the physical properties which determines its failure under stress. A material may fail in tension, compression, shear, or by a combination of these stresses, but any change in the composition of the material usually affects all of them similarly. Thus, a determination of the variation in the tensile strength of a material with changes in composition will indicate similar variations in the compressive and shearing strengths.

Many common enamel defects, such as chipping, fishscaling, and crazing, are mechanical failures of the enamel as a result of stresses set up by differential expansion, rough handling, or other conditions encountered in manufacture or in use. The resistance of an enamel to impact and thermal shock is directly related to its strength because these failures are also mechanical. This investigation was undertaken to see if a variation in the composition of the enamels studied, within workable limits, would result in variations in tensile strength, which could be used to advantage in improving the resistance of the enamel to the different types of mechanical failures.

The scope of this work and the limitations of the method used have not permitted the study of the effect of mill additions, crystalline inclusions, and bubble structure as they exist in actual enamels applied to steel. These factors should be considered in applying the results of this investigation to commercial enamels. The values which are given for tensile strength are not intended for working stresses but are definite values determined under a standard set of conditions by means of which different enamel glasses may be compared.

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 31, 1938 (Enamel Division). Received March 31, 1938.

II. Previous Investigations

Although considerable work has been done by glass technologists, enamelers have given little attention to tensile strength investigations.

Andrews and Smith[1] used a flow of mercury to load a fiber suspended by means of beaded ends in chucks. Tests on an average ground-coat composition gave a tensile strength of about 10 kg. per sq. mm. (14,400 lb. per sq. in.).

Harrison[2] and associates loaded fibers of 0.25 mm. diameter whose beaded ends were gripped in wax seals. They found that a variation of 20% in individual measurements precluded any possibility of determining the effect of variation in the composition of the enamels. An average value, representing 80 tests each on 11 different enamels, was given as 23 kg. per sq. mm. (32,700 lb. per sq. in.).

Among prominent contributors to the measurement of the tensile strengths of glasses are Winklemann and Schott,[3] Griffith,[4] Gooding,[5] Gehlhoff

[1] A. I. Andrews, Enamels, p. 362. Twin City Publishing Co., Champaign, Ill., 1935.

[2] W. N. Harrison, S. M. Shelton, and W. H. Wadleigh, "Strength and Young's Modulus of Some Ground-Coat Enamels for Sheet Iron," *Jour. Amer. Ceram. Soc.*, **18** [3] 100–106 (1935).

[3] H. Hovestadt, Jenaer Glas. (A. Winkelmann and O. Schott cited, p. 149.) Gustav Fischer, Jena, Germany.

[4] A. A. Griffith, "Phenomena of Flow and Rupture in Solids," *Phil. Trans. Roy. Soc.* [London], **A221**, 163 (1920).

and Thomas,[6] Hall,[7] Smekal,[8] and Schwalbe, Badger, and Silverman.[9]

III. Experimental Procedure

The fiber method, used by Gooding,[5] and Gehlhoff and Thomas,[6] and further developed by Schwalbe, Badger, and Silverman,[9] was selected as the most satisfactory method available for the comparison of the tensile strengths of glasses.

All glasses were carefully prepared from standard materials of commercial quality. Dehydrated borax was used. Batches of 400 grams each were smelted in fireclay crucibles in an automatically controlled electric furnace. A record of both batch and furnace temperatures was kept. Each batch was given a standard smelting treatment, the time of smelting being the only variable. The enamels were water-quenched, dried, and

TABLE I

BATCH COMPOSITIONS OF THE ENAMELS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Feldspar	20.00	30.00	26.67	23.33	33.33	20.00	30.00	40.00	26.67	36.67	33.33	30.00	40.00
Borax*	41.00	41.00	37.67	34.33	34.33	31.00	31.00	31.00	27.67	27.67	24.33	21.00	21.00
Quartz	20.00	10.00	16.67	23.33	13.33	30.00	20.00	10.00	26.67	16.67	23.33	30.00	20.00
Na_2CO_3	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Soda niter	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Fluorspar	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Cobalt oxide	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Manganese dioxide	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.01	99.99	99.99	100.00	100.00	100.00	100.01	100.01	99.99	100.00	100.00

* Borax added to batches in dehydrated form; correction made for decrease in water content.

This method permits the use of small, homogeneous glass melts and a precision instrument for breaking fibers in tension. Annealing can be accomplished easily and quickly. Proper design of equipment has eliminated eccentric loading and insured a constant and uniform rate of loading of about 1 lb. per minute.

Thirteen compositions involving variations of borax, feldspar, and quartz within practical limits were selected. These compositions are represented on the ternary diagram (Fig. 1.). The feldspar varied from 20 to 40%, the borax from 21 to 41%, and the quartz from 10 to 30%. The constant portion which was added to the variable 81% is given also in Fig. 1. Table I shows the batch compositions, and Table II gives the melted compositions of the enamels.

milled in porcelain ball mills to pass a No. 60 sieve. Microscopic and X-ray examination of the enamels after this treatment failed to reveal

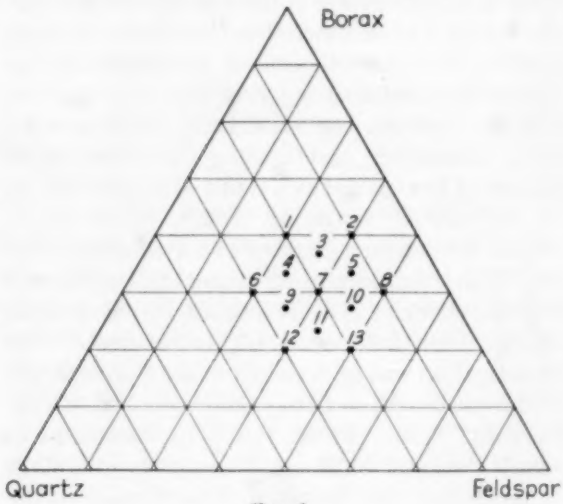


FIG. 1.

Batch Composition (%)

Variable	81
Soda ash	7
Soda niter	4
Fluorspar	6
Cobalt oxide	0.5
Manganese dioxide	1.5
	100.0

any inhomogeneity caused by poor smelting or contamination from milling.

A carefully selected sample of about 100 grams of each enamel was remelted in a platinum

[5] E. J. Gooding, "Investigations on Tensile Strength of Glass," *Jour. Soc. Glass Tech.*, **16** [62] 145–70 (1932); *Ceram. Abs.*, **11** [12] 609 (1932).

[6] (*a*) G. Gehlhoff and M. Thomas, "Brittleness of Opal Glass," *Jour. Soc. Glass Tech.*, **11** [43] 347–62 (1927); *Ceram. Abs.*, **7** [2] 72 (1928).

(*b*) G. Gehlhoff and M. Thomas, "Physical Properties of Glasses and Their Relation to Composition; Mechanical Properties of Glass," *Glass Ind.*, **10** [4] 83–88 (1929); p. 85; [5] 114–19 (1929); p. 114; *Ceram. Abs.*, **8** [7] 490 (1929).

[7] F. P. Hall, "Influence of Chemical Composition on Physical Properties of Glazes," *Jour. Amer. Ceram. Soc.*, **13** [3] 182–99 (1930).

[8] A. Smekal, "Die Festigkeitseigerschaften Sproder Korper," *Ergeb. exakt. Naturw.*, **15** [4] 106–87 (1936).

[9] W. L. Schwalbe, A. E. Badger, and W. B. Silverman, "Tensile Tests of Glasses," *Jour. Amer. Ceram. Soc.*, **21**, [10] 333–38 (1938).

FIG. 2.—Cross-sections of three typical fibers after fracture.

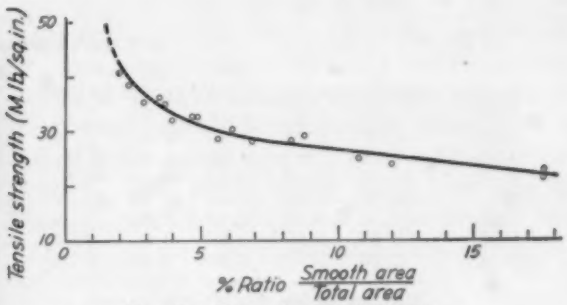
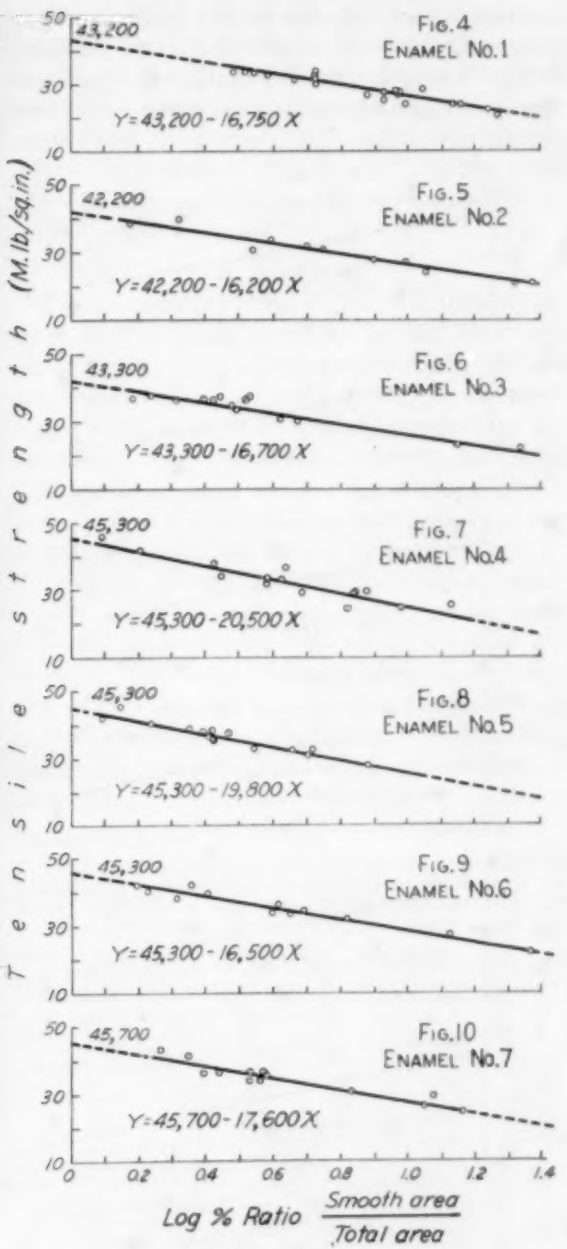


FIG. 3.—Data of enamel No. 11.

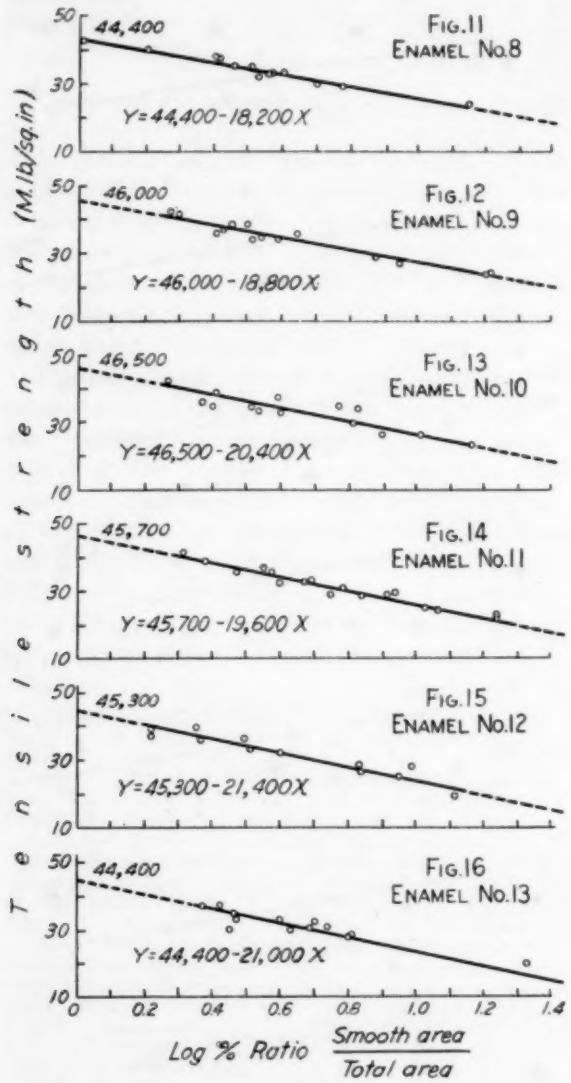


FIGS. 4–10.

TABLE II
MELTED COMPOSITIONS OF ENAMELS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Na_2O	16.72	16.92	15.82	14.73	14.95	13.70	13.90	14.10	12.90	13.12	12.14	11.20	11.40
K_2O	3.20	4.81	4.18	3.58	5.13	3.01	4.52	6.04	3.94	5.41	4.84	4.27	5.69
CaO	0.09	0.13	0.12	0.11	0.14	0.09	0.13	0.18	0.11	0.15	0.13	0.12	0.17
Al_2O_3	5.28	7.94	6.88	5.91	8.44	4.97	7.44	9.95	6.49	8.94	7.96	7.03	9.40
B_2O_3	20.00	20.03	18.02	16.10	16.12	14.24	14.25	14.27	12.49	12.50	10.77	9.12	9.13
SiO_2	44.05	39.46	44.52	49.38	45.07	54.00	49.65	45.42	54.30	50.00	54.40	58.85	54.73
CaF_2	8.00	8.02	7.84	7.68	7.70	7.53	7.54	7.55	7.39	7.40	7.25	7.11	7.12
CoO	0.67	0.67	0.66	0.64	0.64	0.63	0.63	0.63	0.62	0.62	0.61	0.59	0.59
MnO_2	2.00	2.01	1.96	1.92	1.92	1.88	1.88	1.88	1.85	1.85	1.81	1.78	1.78
	100.01	99.99	100.00	100.05	100.11	100.05	99.94	100.02	100.09	99.99	99.91	100.07	100.01

crucible. Each melt was held for twelve hours at a temperature below 1900°F to insure complete fining. Using a platinum bait, long fibers were drawn mechanically as uniformly as possible from the melts.



FIGS. 11–16.

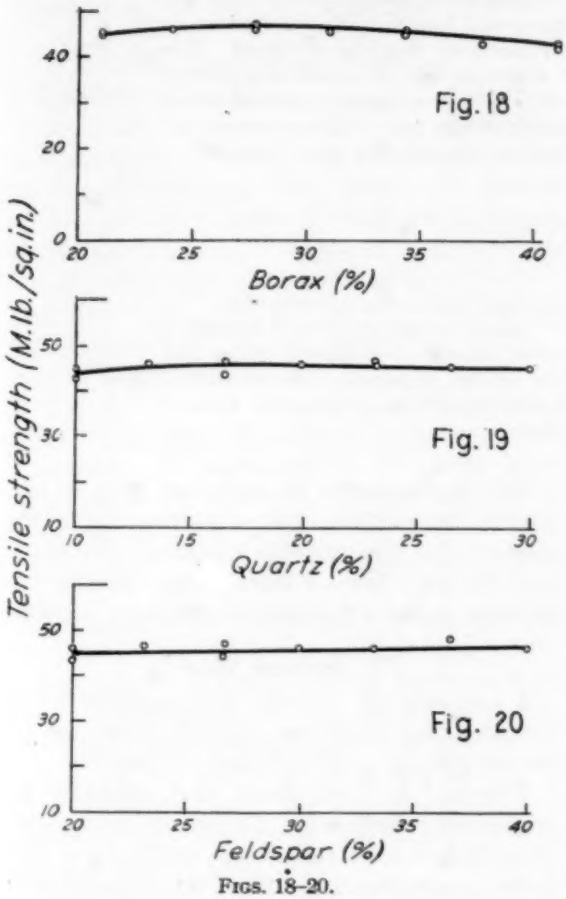
Short sections of the long fibers were broken off and the ends formed into beads in a small flame. The beads were centered by hanging the fiber vertically from a chuck and rebeading the ends, reversing the fiber several times during the process. The beaded fibers were necked down and annealed in a small electric furnace while hanging in a vertical position. Only round fibers of a diameter of 0.7 mm. ±0.1 mm. in the smallest section were retained. Fibers of this diameter were small enough that the variation in tensile strength due to "skin effect" was negligible.

FIG. 17.—Tensile strength (1000 lb./sq. in.) when

$$\text{Log}\left(100 \times \frac{\text{smooth area}}{\text{total area}}\right) = 0.$$

Immediately after annealing, the fibers were broken in tension in the machine described by Schwalbe, Badger, and Silverman.[9] The machine consists essentially of a metal cylinder, closed at the top, floating in a mercury bath, and attached at the top to the lower end of a fiber, the upper end of which was fixed. A vacuum was applied to the interior of the cylinder, raising the mercury and thus loading the specimen.

After rupture, the enamel fibers were found to possess a cross-section, typical of glasses, which contains a small smooth area while the remainder is rippled. Photographs of cross-sections of three typical fibers after fracture are shown in Fig. 2. The diameters of the total section and the axes of the small, elliptical-shaped, smooth area were measured with a microscope fitted with a micrometer eyepiece. From these measurements, the



FIGS. 18–20.

two areas were calculated. As shown by Schwalbe, when the unit stress at failure based on the area of the total section is plotted against the percentage ratio of the smooth area to the total area, a logarithmic curve is obtained. One of these curves is shown in Fig. 3. Plotting the logarithm of the percentage ratio of the areas against the unit stress based on total area results in a straight line which can easily be extrapolated to log = 0. The value of the tensile strength at this point represents the tensile strength of a fiber whose smooth area is 1% of the total cross-section. This is the value which was used to compare the different enamels. The straight line best representing the data was determined by the method of least squares.

IV. Results

The results of the tests on each enamel are given in Figs. 4 to 16, inclusive. The effect of composition upon the tensile strength of sheet-iron ground-coat glasses is shown in Fig. 17. Cross-sections of the ternary field are shown in Figs. 18 to 20, inclusive. These graphs indicate the effect of borax, quartz, and feldspar, respectively, on the tensile strength.

V. Summary

For all practical purposes, there is little difference in the tensile strength of the sheet-iron ground-coat glasses investigated. The largest variation encountered was only 10% of the total. The tensile strength is slightly lowered by the addition of borax in amounts greater than 30%. The tensile strength is raised slightly by the addition of quartz until 20% has been added. Feldspar also tends to raise the tensile strength slightly.

These results indicate that little improvement, due to increased enamel strength, can be made in the resistance of sheet-iron ground-coat enamels to mechanical failures, such as chipping, fishscaling, crazing, impact, and thermal shock failures, by varying the feldspar, borax, and quartz contents of enamels within practical working limits.

Acknowledgments

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EFFECT OF PARTICLE SIZE ON PLASTICITY OF KAOLINITE*

By H. Whittaker

Abstract

A Kentucky ball clay and a Georgia kaolin were resolved into seven practically monodisperse fractions, ranging from 0.2 to 20.0 microns in mean size. The distribution of sizes and the physical characteristics of the fractions were determined to place the fractions on a comparable basis. Plasticity, drying shrinkage, and dry strength measurements were made on the fractions. There was no definite relationship between drying shrinkage and particle size, but, in general, the drying shrinkage increased with decreasing particle size. The drying shrinkage measurements, however, afforded a means for computing the thickness of water films at the maximum plasticity developed. This computed thickness was between 90 and 160 Angstrom units at maximum plasticity. The dry strength increased up to a certain limit in direct relation with increased area of surface or decreased particle size. The optimum plasticity value, taken as the product of yield and strain, increased with increasing surface area according to the relation,

$$\text{Log } S = AP + B.$$

Where S = surface available per 100 g. clay.
P = plasticity.
A and B = constants.

The constant, B, is equal to 180×10^4 for the kaolinite used in this investigation. This means that there must be more than 180×10^4 square centimeters of total surface per 100 grams of clay on the basis of platelike particles before the material will exhibit plasticity. This surface represents a monodisperse system of particles approximately 2 microns in diameter; systems containing particles more than 2 microns in diameter exhibit the Osborne-Reynolds close-packing effect.

I. Introduction

That the finer clays are more plastic than the coarser clays has led some investigators to attribute plasticity alone to fineness of grain; other factors than grain size, however, appear to influence that property of pastes which enables them to be deformed permanently without fracture.

The factors which seem to influence the magnitude of forces under which clay-water pastes will yield plastically include the following: (1) shape of grains, (2) size, (3) temperature at time of test, (4) time of application of deforming force, and (5) nature and interactions of interboundary medium, such as (*a*) amount of liquid medium, (*b*) electrolyte content, and (*c*) surface effects of grains. It is interesting to note the similarity of these factors to those said to be the governing factors in the elastico-plastic properties of metals.

These variables together influence the deformability of mineral-water pastes. The influence of the remaining variables accordingly must be considered when studying the effect of any one variable.

This investigation is concerned with a systematic study of the effect of particle size on the plasticity of the mineral kaolinite. With the methods used here, a more precise relationship has been obtained than has hitherto been possible.

II. Previous Work

A vast amount of evidence is available which indicates that grain size is a most important influencing factor on the plasticity of clay.

Wheeler,[1] in 1896, found that plasticity increased with the fineness of grind, and many other investigators have stated that smallness of particles causes plasticity. Later investigators have been more specific in their measurements. In his attempt to confirm the function of extremely fine particles upon the plasticity of bodies, Isomatsu[2] concluded that particles less than one micron in diameter affected the formability directly.

Salmang and Kind[3] resolved Zettlitz kaolin into

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 29, 1938 (General Session on "Constitution of Clay"). Received March 18, 1938.

[1] H. A. Wheeler, "Clay Deposits," *Mo. Geol. Surv.*, No. 11, p. 102 (1896).

[2] Reizo Isomatsu, "Studies on Relations between Fineness of Particles and Plasticity of Ceramic Bodies," *Imp. Ceram. Expt. Inst. Rept.*, No. 11, pp. 13–41 (1933).

[3] H. Salmang and J. Kind, "Relations of Various Physical, Chemical, and Technical Properties of Clays," *Ber. deut. keram. Ges.*, **15** [7] 331–57 (1934); *Ceram. Abs.*, **14**, [5] 127 (1935).

five fractions and determined their size distribution. They found that the plasticity as determined by the Pfefferkorn method was definitely related to grain size.

Davies, Green, and Donnelly[4] determined the particle-size distribution of six typical potting china clays; they also determined the Atterberg plasticity number for these clays and found that there was some indication of a relationship between grain distribution and plasticity.

III. Experimental Procedure

To obtain a broad range of size distribution and at the same time to compare two general types of clay used commercially, a Kentucky ball clay and a Georgia kaolin were fractionated.

The clays were dispersed in water with the predetermined amount of deflocculant required for stable suspensions of unit particles. The ball-clay suspensions were split up into four fractions by repeated settlings under gravity for the fraction of more than one micron. The three fractions under one micron were produced by repeated centrifuging with a Sharples supercentrifuge. The kaolin suspensions were split into three monodisperse systems by repeated settlings for the fine fraction, and a short-column elutriator, similar to that developed by Cooke,[5] was used for the coarse fractions.

The particle-size distribution curves for these fractions were obtained by a combination of the Casagrande hydrometer method with a settling and centrifuging technique developed by Norton and Speil.[6] The cumulative weight curves obtained for the fractions are shown in Fig. 1. These curves represent the weight percentage of clay finer than any mean equivalent spherical diameter of grain size.

More useful for purposes of comparison of plasticity is the total surface available per 100 grams of clay in any fraction. This surface, S, contained in the increment of weight, W, between any two values of particle diameter, D, when the particles are considered to be square plates, will be

$$S = \int_{D_1}^{D_2} \frac{dW}{dD} \cdot dD \left[\frac{2d^2 + 4d^2X}{2\zeta d^2 X}\right] = \frac{1+2X}{dX}\left[W_{D_2} - W_{D_1}\right].$$

Where ζ = density of material.
d = mean diameter between limits of D_2 and D_1 (taken as equivalent spherical diameter obtained from settling curves).
X = ratio of thickness to length (taken as 0.08, the value obtained from microscopic studies of fractions).

Unfortunately this equation can not be solved directly because the function dW/dD is unknown. A means for approximating the desired value is to

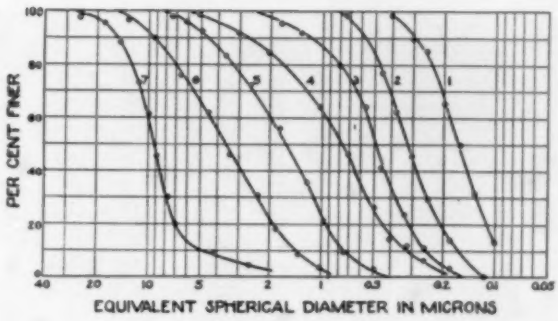


FIG. 1.

sum up values obtained between D max. and D min. by taking small increments of D and W, where d will equal the mean value.

$$S = \sum_{D_{\min.}}^{D_{\max.}} \frac{\Delta W}{\Delta D} \cdot \Delta D f(d_1) + \frac{\Delta W}{\Delta D} \cdot \Delta D f(d_2) + \ldots . \frac{\Delta W}{\Delta D} \cdot \Delta D f(d_n).$$

The smaller the increments that are chosen, the more closely will the approximation approach the true value of S.

The values of $S/100$ grams of clay computed for square plates are given in Table I.

TABLE I

Fraction No.	$S/100 \times 10^4$ cm.^{2}
7	13
6	392
5	794
4	1750
3	2710
2	3880
1	7100

In placing the fractions on a comparable basis, a knowledge of the physical structure, such as the shape of the particles, is important.

Upon examination with the petrographic microscope, no particles in fraction 1 were visible in

[4] R. J. Davies, R. A. Green, and H. F. E. Donnelly, "Researches on China Clay," *Trans. Ceram. Soc.* [Eng.], **36** [4] 173–200 (1937); *Ceram. Abs.*, **17** [2] 83 (1938).

[5] S. R. B. Cooke, "Ore Dressing Studies: (C) Short-Column Hydraulic Elutriator for Subsieve Sizes," *U. S. Bur. Mines Rept. of Invest.*, No. 3333, 50 pp. (Feb., 1937); *Ceram. Abs.*, **17** [6] 227 (1938).

[6] F. H. Norton and S. Speil, "Measurement of Particle Sizes in Clays," *Jour. Amer. Ceram. Soc.*, **21** [3] 89–97 (1938).

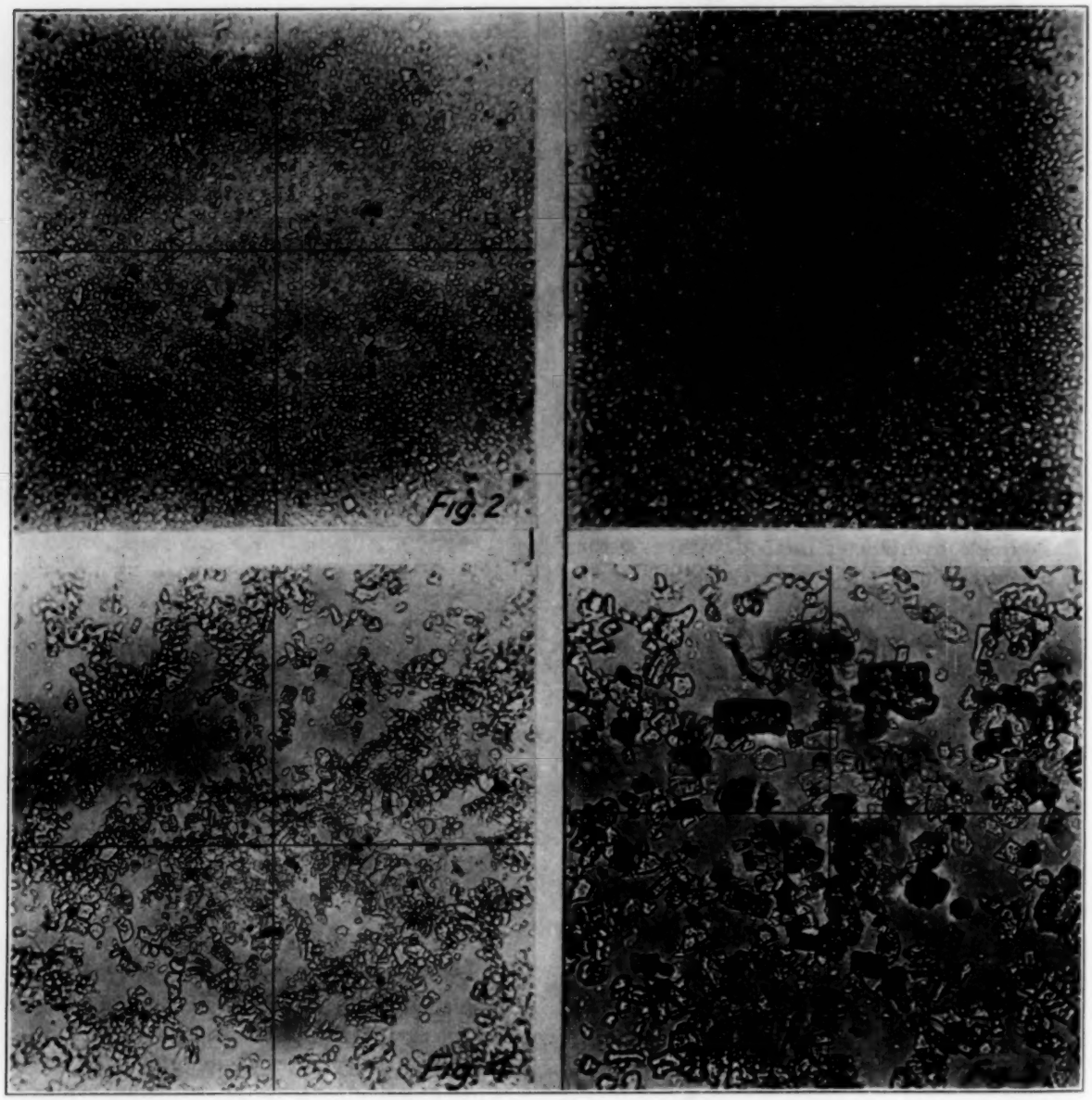
white light. Only a small percentage of the particles contained in fractions 2 and 3 were visible; these showed vigorous Brownian movement.

The photomicrographs in Figs. 2, 3, 4, and 5 show representative fields for the coarser fractions 4, 5, 6, and 7 (Table I); the particles tend to become more platelike in shape as the size decreases. The largest sizes show booklike parcels characteristic of kaolinite. It appears that attrition tends to flake off the plates contained in the booklike crystals.

Examination of the finer fractions with a slit-ultramicroscope showed marked twinkling as well as vigorous Brownian movement, thereby further substantiating the presence of platelike particles.

Another indication of plates was the observation of microscopic di-tyndallism produced on stirring a dilute suspension of the fractions. The finer suspensions, which showed the effect to a greater extent than the intermediate sizes, were not observable in the coarser fractions.

X-ray patterns of all the fractions were identi-



FIGS. 2–5.

cal, except the pattern for fraction 5 which contained silica lines in addition. The lines and estimated intensities for the fractions and for a standard pattern of kaolinite were in perfect agreement.

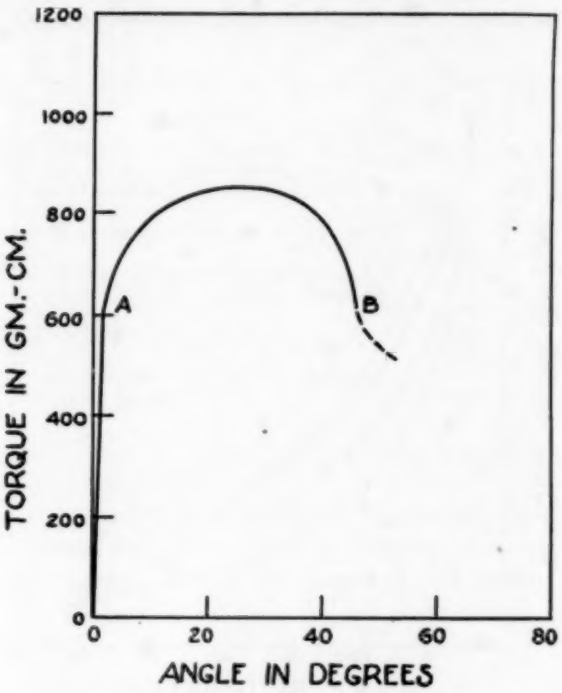


FIG. 6.

It has been proposed that the kaolinite structure is built up of alternate layers or sheets of silicon-oxygen and aluminum-oxygen packing units. This type of structure leads to a cleavage which is conducive to platelike particles. Seven fractions, composed of platelike particles, were therefore made available for plasticity, dry strength, and drying shrinkage measurements.

Fraction 4 was electrodialyzed to determine to some extent the effect of electrolytes on the properties.

The measurements of plasticity were made by a torsion method as described in detail by Norton.[7] The instrument gives a means for twisting a tubular specimen and recording the instantaneous stress-strain diagram for the material tested. The clay fractions were made up into test pieces of three water contents, *viz.*, (1) fairly dry, (2) to maximum plasticity by feel of the clay, and (3) fairly wet. All the specimens were tested on the machine under standard conditions of temperature and time.

Figures 6 and 7 show typical plasticity diagrams for fractions 1 and 6; point *A* of Fig. 6 is taken as the yield value or elastic limit of the clay; the range from *A* to *B*, the fracture point, is taken as the extensibility of the clay.

The progressive drying shrinkage for the fractions was obtained by the determination of the shrinkage on a tubular specimen simultaneously with the loss in weight at a constant temperature; the apparatus used is described by Norton.[8]

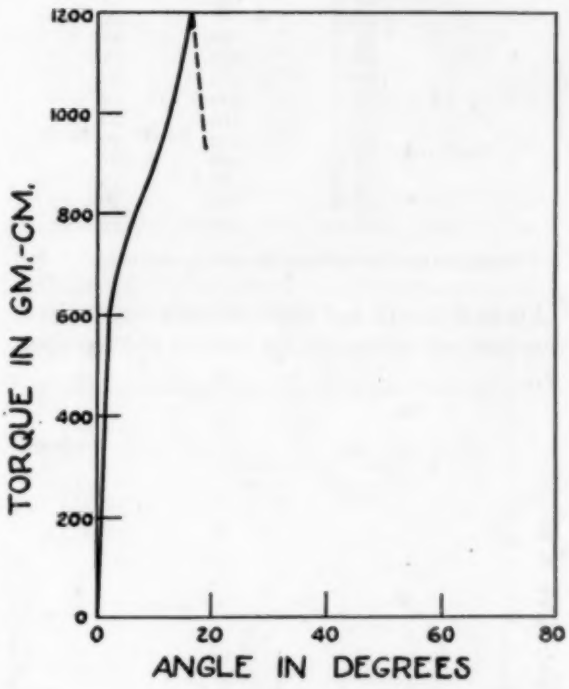


FIG. 7.

The transverse breaking strengths of the dried fractions were obtained in the usual manner. A test bar supported between two knife edges was loaded to the breaking point by a weight pan attached to a beam.

IV. Results

(1) Plasticity

The average yield and strain values for the various fractions at the water content of the test specimens are given in Table II.

[7] F. H. Norton, "An Instrument for Measuring the Workability of Clays," *Jour. Amer. Ceram. Soc.*, **21** [1] 33–36 (1938).

[8] F. H. Norton, "Some Notes on Nature of Clay, II," *ibid.*, **16** [2] 86–92 (1933).

If the yield and strain values are plotted for the various fractions against water content, two families of curves are obtained as shown in Fig. 8; the yield and deformability as well as the water required increases as the particle size decreases.

TABLE II

AVERAGES OF PLASTICITY DATA*

Material (fraction No.)	Av. water content	Av. yield values	Av. strain values
1	35.8	280	37
	32.4	490	21
	29.7	600	7
2	32.2	300	27
	30.2	400	20
	29.4	460	14
3	29.5	210	36
	31.4	80	45
	26.3	400	21
4	26.0	170	30
	23.7	290	19
	22.2	415	10
4 (dialyzed)	28.2	180	40
	26.6	480	22
5	22.6	65	25
	21.5	200	22
	21.0	290	17

* Averages are for at least six determinations.

Figure 9 is a plot of yield value versus strain at constant water content for each of the fractions.

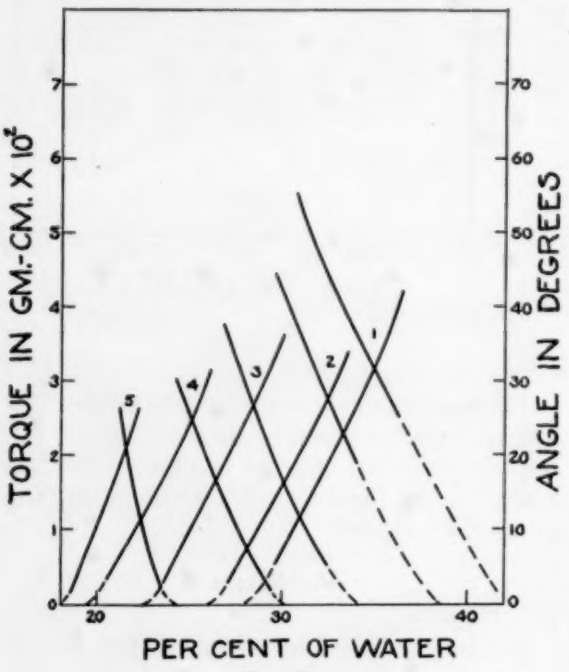


FIG. 8.

This family of curves lies in the proper order, corresponding to the average sizes of the particles contained in the fractions. These curves indicate the true plastic ranges of the clay fractions. As the water content is increased, the strain values increase slowly and then rapidly, at which point the clay-water mixture takes on the characteristic flow properties of suspensions. Conversely, as the water content is decreased, the strain values

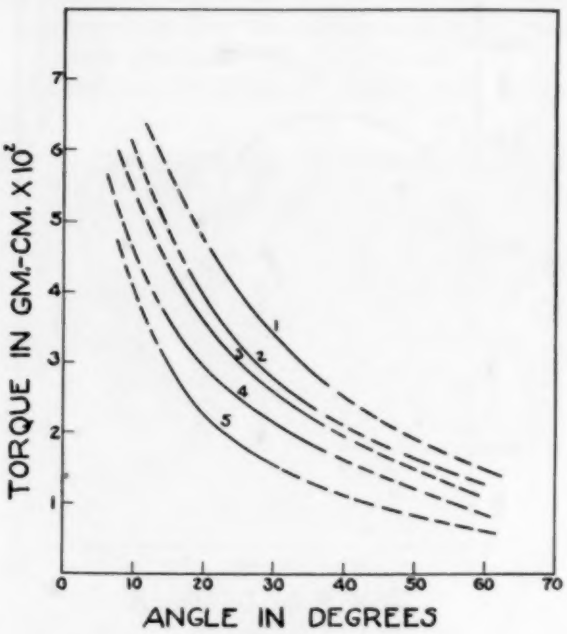


FIG. 9.

decrease and approach zero, while the yield values increase slowly at first and then very rapidly, at which point the material takes on the properties of dried clay which requires a relatively large deforming force and exhibits little extensibility.

Accordingly, the plasticity of clay must be a function both of the yield and the extensibility. The precise relationship of these functions is not at present known. For comparative purposes, however, the product of the experimental yield and strain values can be taken as a measure of the plasticity. The maximum or optimum plasticity will then be reached when the product of the yield and the strain is a maximum. A plot of this product or plasticity value against water content gives the family of curves for the fractions (Fig. 10). The maximum on each curve will correspond to the maximum plasticity for each fraction. The plasticity values obtained from the curves shown in Fig. 10 are given in Table III. The curves of Fig. 10 show that the

range of water content in which the material exhibits plasticity increases as the particle size decreases. This observation is consistent with those found in the literature. Indeed the Atterberg plasticity number, used as the measure of the plasticity, is based on the fact that the more plastic clays are workable over a larger range of water content.

From the curve, it is apparent that the value of B is 180×10^4. This means that the total area of surface per 100 grams of kaolinite, having the physical and chemical characteristics previously mentioned, must be more than 180×10^4 sq. cm. before plasticity will be exhibited.

TABLE III

Fraction No.	1	2	3	4	5	6	7	(4) (dialyzed)
Optimum plasticity (degrees/g./cm.)	10,200	8200	7600	6250	4400			9100
Yield at optimum plasticity (g./cm.)	320	290	280	250	210			290
Strain at optimum plasticity (degree of twist)	32.0	28.7	27.6	25.0	21.0			32
H_2O at optimum plasticity on wet basis (%)	34.9	32.3	28.3	25.0	21.6			27.4
Film thickness at optimum plasticity (Å)	86	119	74	89	160			149
Dry shrinkage at optimum plasticity (vol. %)	30.5	23.0	10.0	7.8	6.0	0	0	
Transverse dry strength (lb./sq. in.)	296.6	457.8	130.4	47.4	64.5	14.0	4.6	13.5
Surface/100 g. $\times 10^4$ sq. cm.	7100	3880	2710	1750	794	392	13	1750
Av. particle size (equivalent spherical diameter (microns))	0.135	0.28	0.45	0.55	1.05	2.2	8.5	0.55

The most significant result of this investigation is shown by a plot of plasticity values against the log of surface area per 100 grams of clay as seen in Fig. 11. An expression can be written for this curve and will be as follows:

$$\text{Log } S = AP + \log B.$$

Where S = total area of surface per 100 g. clay.
P = product of yield and strain at optimum plasticity.
A and B = constants.

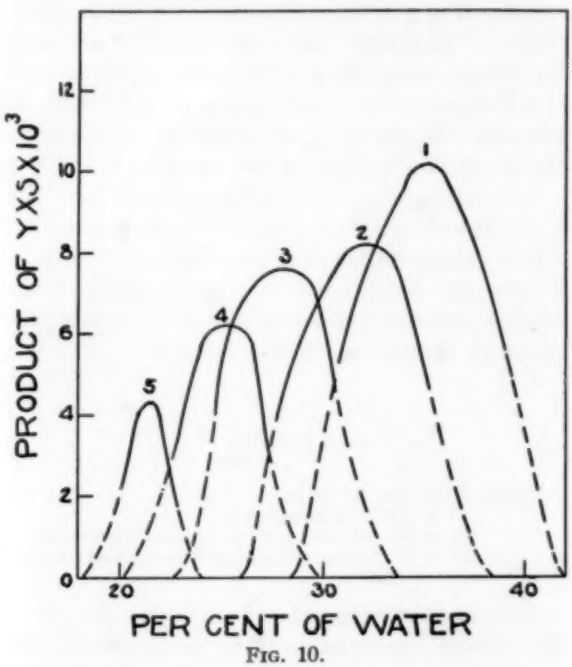


FIG. 10.

The surface represented here can not be the actual surface which enters into the interaction of forces that produce resistance to deformation and fracture. The actual interacting surface will probably be some ratio less than one of the total surface as calculated, providing the packing arrangement of the particles remains constant with changing size. Under these conditions of constant packing arrangement, the substitution of some value (which is not determinable experimentally at present) for actual surface will merely move the curve on the surface axis but will not change the slope of the curve.

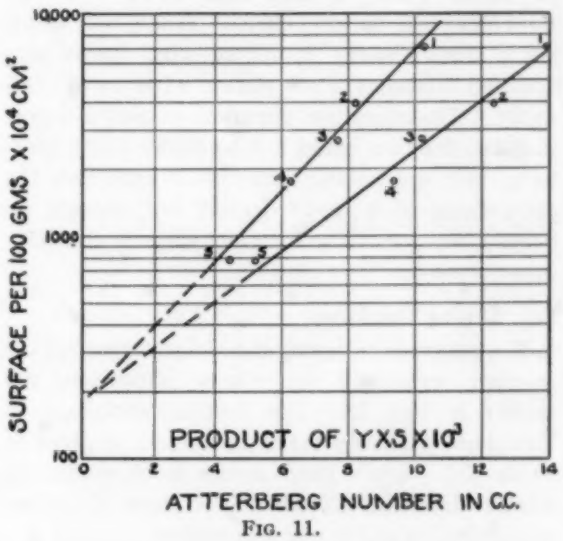


FIG. 11.

The effect of dialysis on the plasticity can be seen by a comparison of the values for fraction 4, dialyzed and undialyzed. The undialyzed clay gives a plasticity value of 6250 at 25.0% water, and the dialyzed clay gives a plasticity value of 9100 at 27.4% water. A change in the surface characteristics of the material by the addition of electrolytes probably will move the plasticity-surface curve up or down on the surface axis or perhaps change the shape of the curve.

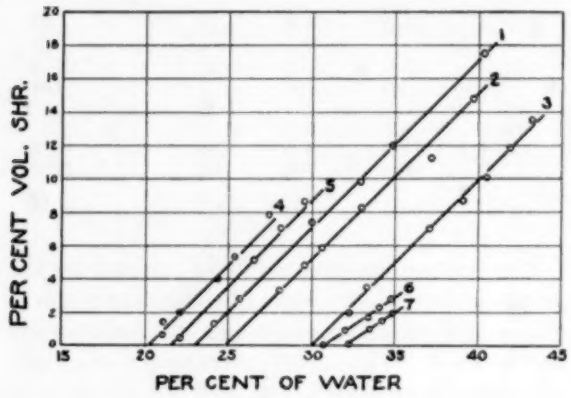


FIG. 12.

When the available surface is less than 180 × 10^4 sq. cm., the material exhibits the Osborne-Reynolds close-packing effect. Fraction 7, which has a surface of 13 × 10^4 sq. cm., shows pronounced dilatency when wetted with about 35% water. The effect was apparent to such a degree that the fraction could not be molded into plasticity test specimens. Fraction 6 exhibited the phenomena to a lesser degree, but enough dilatency was present to interfere with its plasticity measurement.

(2) Drying Shrinkage

The progressive drying shrinkage curves for the fraction, expressed as volume shrinkage, are shown in Fig. 12. The volume shrinkage at maximum plasticity for each fraction is given in Table III. While there seems to be no precise relationship, there tends to be more shrinkage manifested as particle size decreases.

(3) Dry Strength

The transverse strength in pounds per square inch of the dried clay for each of the fractions and for one dialyzed fraction is given in Table III. The values listed are averages of a number of test bars.

The dry strength increased with decreasing particle size until the mean equivalent diameter attained was 0.28 micron, represented by fraction 2 where a decrease became evident. More experimental data would be required before precise relationships for dry strength and drying shrinkage could be determined.

(4) Film Thickness

Of extreme interest and significance in the explanation of the plasticity of clay is the thickness of the water films between the particles. These thicknesses show a means for determining the distances separating the particles which gives an inkling as to the magnitude of forces of attraction whether they be due to a solvation or a mutual attraction of the particles.

If it is assumed that there are two plates of zero thickness and total area, A, to be separated by a film of water of thickness, T, then the volume of water which would be required to cover the plates with an even thickness of film, T, would be $V = A/4 \times 2T$. The thickness of film will be $T = 2V/A$.

If V equals the difference in volume of the water contained in any monodispersed fraction between that at maximum plasticity and that at zero shrinkage when the particles are touching and if A is equal to the total surface per unit mass of material, the value, T, will equal the thickness of the water film separating the particles.

The computed film thicknesses for the fractions at maximum plasticity are given in Table III. These values, although of the same order of magnitude, are consistently five times greater than when calculated according to the equation proposed by Wilson[9] which is as follows:

$$T = \frac{Y}{\frac{2}{3}N + \frac{1}{3}M}.$$

Where T = film thickness.
Y = linear shrinkage (%).
N = No. of films per cm. (plates stacked flat).
M = No. of films per cm. (plates stacked on end).

This can not be considered too large a deviation, for Wilson's ratio of packing arrangement is a pure assumption without experimental basis, and a slight change in the ratio to $^3/_4$ and $^1/_4$ will bring the two comparative values into agreement.

[9] E. O. Wilson, "Plasticity of Finely Ground Minerals with Water," *Jour. Amer. Ceram. Soc.*, 19 [4] 115–20 (1936).

V. Conclusions

(1) Plasticity is directly related to surface area and inversely related to particle size.

(2) The relation of plasticity to surface area of kaolinite can be expressed by $\log S = AP + \log B$, where S equals surface area per 100 grams of clay; P equals product of yield and strain; and A and B are constants.

(3) Kaolinite, under the conditions of test as outlined, exhibits plasticity only when the surface area is greater than 180×10^4 square centimeters per hundred grams of clay, *i.e.*, when $B = 180 \times 10^4$.

(4) Kaolinite exhibits the Osborne-Reynolds close-packing effect when the system contains particles more than two microns mean spherical diameter.

(5) The thickness of water films at optimum plasticity are of the order of magnitude of 90Å.

(6) When hydrogen is exchanged for the bases, the plasticity increases.

(7) The removal of the exchangeable bases increases the water required to form a plastic mix of kaolinite.

(8) The plasticity of kaolinite is not due to a coating of colloids on the surface of the particles but is exhibited only when the particles contained in the system, or a sufficient amount of the particles, are of colloidal dimensions.

(9) The drying shrinkage increases, in general, with decreasing particle size.

(10) The dry strength increases, in general, with decreasing particle size until a maximum is reached; then dry strength decreases.

(11) When hydrogen is exchanged for the bases, the dry strength decreases.

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DIRECT DETERMINATION OF SODIUM OXIDE IN FELDSPAR*

By E. W. Koenig

Abstract

A method for the direct determination of sodium oxide in feldspars is described. Data derived from an investigation conducted to determine the optimum conditions for the accurate estimation of this alkali metal by the prescribed procedure are tabulated and the results are discussed. The application of the method to the analysis of other related silicates is mentioned briefly.

I. Introduction

The estimation of percentage sodium oxide in feldspar, as in other silicates, is ordinarily preceded by a preliminary removal of those elements which in the usual course of analysis interfere, *e.g.*, silica, the R_2O_3 group, and the alkaline earths.[1] The alkali metals, sodium (lithium) and potassium (rubidium and cesium), are then isolated as chlorides, and the sodium is determined either directly, in an aliquot of the aqueous solution of the chlorides as a salt of uranyl zinc acetate,[2] by difference after the removal of potassium as perchlorate or chlorplatinate, or indirectly by calculation from the ratio of Cl^- to total alkali chlorides.[3]

The isolation of the alkali chlorides by any of the methods cited is somewhat involved, and close attention to the details of the respective methods is required if results of requisite accuracy are to be expected.

It has been shown that all feldspars are completely soluble in hydrofluoric acid.[4] Glaze,[5] in his work on the direct determination of sodium oxide in glasses, made use of HF and $HClO_4$ for decomposition of the sample and removal of silica, converting the resultant perchlorates to oxychlorides of the R_2O_3 group, to oxides of the alkaline earths, and to chlorides of the alkalis by judicious heating, finally estimating sodium as sodium uranyl zinc acetate in an aliquot of the aqueous solution of the salts. These conversions and the solution of the large quantities of oxychlorides introduced by the aluminum are difficult to attain. More recently Churchill, Bridges, and Miller[6] described a method for the determination of sodium in aluminum metal in which the precipitation of the triacetate salt was accomplished in solutions approximately 4 *N* in sulfuric acid. Caley[7] made use of the reaction to determine the sodium content of analytical calcium carbonate with seemingly good precision and accuracy.

From these data, it would appear that the removal of silica as the tetrafluoride and of excess fluorine by means of HF and $HClO_4$ (H_2SO_4 is precluded because of the possibility of $CaSO_4$ ($BaSO_4$ and K_2SO_4) formation) would allow the determination of sodium as $(UO_2)_3ZnNa(CH_3-$

Note: There is some evidence that large quantities of aluminum perchlorate, when heated in platinum, decompose to the oxide rather than to the oxychloride, in accordance with the following reaction:

$$4Al(ClO_4)_3 = 2Al_2O_3 + 6Cl_2 + 21O_2.$$

The hydroxide, sparingly soluble in solutions weakly acid, is formed upon the addition of water.

This conversion is dependent upon a localization of heating of the dish and does not take place in the analysis of feldspar when working with 100 mg. samples. Larger samples must be handled with extreme care at this point. Glaze,[5] working with glasses, did not find this difficulty, owing to the small quantities of aluminum present in his samples.

* Received March 8, 1938.

[1] (*a*) D. E. Sharp, "Feldspar as a Constituent of Glass," pp. 72–74. D. E. Sharp, editor, National Feldspar Assn., New York, 1937.

(*b*) H. B. Knowles and J. C. Redmond, "Analysis of Feldspar," *Jour. Amer. Ceram. Soc.*, **18** [3] 106–12 (1935).

(*c*) S. R. Scholes, "Rapid Method for Estimation of Soda in Glasses," *ibid.*, **15** [3] 342–43 (1932).

(*d*) E. W. Koenig, "Determination of Alkalis in Feldspars: Modified Hydrofluoric Acid Method," *Ind. Eng. Chem., Anal. Ed.*, **7** [5] 314–15 (1935); *Ceram. Abs.*, **15** [1] 43 (1936).

[2] H. H. Barber and I. M. Kolthoff, "Specific Reagent for Rapid Gravimetric Determination of Sodium," *Jour. Amer. Chem. Soc.*, **50** [6] 1625–31 (1928).

[3] R. B. Schaal, "Determination of Alkalis in Vitreous Enamels," *Jour. Amer. Ceram. Soc.*, **13** [2] 113–25 (1930).

[4] E. W. Koenig, "Analysis of Feldspar, Determination of Ferric Oxide: I, Decomposition of Sample," *ibid.*, **20** [7] 230–33 (1937).

[5] F. W. Glaze, "Direct Determination of Soda in Soda-Lime Glasses by Precipitation as Uranyl Zinc Sodium Acetate," *ibid.*, **14** [6] 450–51 (1931).

[6] H. V. Churchill, R. W. Bridges, and A. L. Miller, "Determination of Sodium in High Aluminous Material," *Ind. Eng. Chem., Anal. Ed.*, **8** [5] 348–49 (1936); *Ceram. Abs.*, **16** [11] 353 (1937); see also H. V. Churchill and R. W. Bridges, "Chemical Analysis of Aluminum," p. 71. Aluminum Research Lab., New Kensington, Pa., 1935.

[7] E. R. Caley, "Determination of True Sodium Content of Calcium Carbonate Intended for Use in the J. Lawrence Smith Method," *Ind. Eng. Chem., Anal. Ed.*, **1**, 191–92 (1929).

$COO)_9 6H_2O$ to proceed without further separations or conversions to neutral solutions, provided that free $HClO_4$ introduced no complications. Preliminary trials indicated that $HClO_4$ had no deleterious effect if held to a small percentage of the total volume.

II. Reagents and Equipment

(1) Zinc Uranyl Acetate

The reagent was prepared by a modification of the method employed by previous investigators (see footnotes 1 (*b*), 2, 5, and 6).

Solution A		Solution B	
$UO_2(CH_3COO)_2 2H_2O$	10 g.	$Zn(CH_3COO)_2 3H_2O$	30 g.
Water	49 g.	Water	32 g.

Each salt is brought into solution by gentle warming and stirring; solution A will remain cloudy owing to the hydration of the uranium salt. When in solution, 6 grams of 30% acetic acid are added to solution A and 3 grams to solution B. The solutions are mixed, and a few milligrams of sodium chloride are added to insure saturation with the sodium salt and are allowed to stand at room temperature for 24 hours. The clear supernatant liquid is used as a precipitant. It is well to add a few crystals of barium chloride to remove any sulfates introduced by the uranium salt. The reagent is stable and large quantities may be prepared where the volume of analyses warrants. This method of reagent preparation allows a more rapid solution of the individual salts than procedures wherein the acetic acid is added at the outset.

(2) Saturated Ethyl Alcohol

A quantity of 95% ethyl alcohol is saturated with the triacetate salt by shaking and digestion.

(3) Ether

A U.S.P. grade of ether is suitable for the final wash solution.

(4) Hydrofluoric and Perchloric Acids

The commercially available chemically pure reagents, 48% hydrofluoric and 70% perchloric acids, were used.

(5) Filtering Crucibles

Thirty-milliliter Schott glass fritted crucibles of medium porosity, sold under the designation 1G4, were found suitable.

(6) Temperature Control Equipment

Temperatures from 10° to 30°C were achieved in a mechanically stirred water bath, the temperature being controlled by means of a toluene bulb thermostat connected through a sensitive relay to the lamp bank used for heating the bath. Exploration of the active portion of the bath indicated a maximum variation of 0.3°C from the temperature noted. For temperatures above 30°C, a thermostatically controlled convection oven was used. A precision of 1°C was easily attainable.

The literature covering the determination of sodium as sodium zinc uranyl acetate is somewhat contradictory, but certain conditions for the temperature of precipitation, precipitation limits, sample solution, reagent ratio, and interference of foreign salts, appeared to be more or less established. Preliminary trials were conducted in such a manner, when possible, to conform to the conditions laid down by earlier investigators. Later, many of these close controls of physical conditions were found to be unnecessary, and in a few cases the results of previous research, particularly those of temperature control and interference of foreign salts, could not be confirmed under the conditions outlined in the proposed procedure.

III. Experimental Procedure

The procedure used is described as follows:

Transfer 0.1000 gram of the finely ground (−200-mesh) and dried (105°C) sample to a 75-ml. Payne-type platinum dish. Moisten with water, add 0.5 ml. $HClO_4$ and 10 ml. HF, and evaporate to heavy fumes of $HClO_4$. Moisten with water, add a few drops of $HClO_4$, and repeat the evaporation, this time to practically complete expulsion of the acid fumes. Cool, add a few milliliters of water, and warm to solution. Transfer to a 30-ml. beaker, and, if there is a slight opalescence caused by the hydrated aluminum perchlorate, add two drops of $HClO_4$.

Adjust the volume to 5.0 ml. and cool to 22°C. Twenty milliliters of the precipitant which has been brought to equilibrium at the prescribed temperature are added, and the solution is stirred to precipitation. Allow to digest for 30 minutes at the temperature noted.

Filter through a fritted glass crucible, transferring the residue and washing several times with

the reagent[8] and finally with the alcoholic wash. The total volume of washings need not exceed 15 ml. Suck completely dry at the pump and then add 15 ml. of ether, drawing air through the crucible until the ether is completely removed. Wipe the crucible with a damp cloth, desiccate, and weigh. The salt can be dried at 80°C to constant weight as a substitute for the final ether wash.

$$(UO_2)_3ZnNa(CH_3COO)_9 6H_2O \times 20.15 = \% Na_2O.$$

Table I is indicative of the relative precision and accuracy of the method when compared with the same separation conducted on neutral aqueous solutions of the alkali chlorides obtained by one of the methods cited earlier.[1(d)]

TABLE I

Sample	Previous method Na_2O (%)	Proposed method Na_2O (%)		
70	2.38*	2.40	2.40	2.41
99	10.72*	10.70	10.70	10.73
B917	7.28	7.32	7.32	
B918	3.54	3.57	3.57	3.59
B919	2.65	2.67	2.67	2.68
M6900	1.40	1.44	1.46	1.48
M6901	5.41	5.41	5.44	5.44
M6902	9.21	9.21	9.21	9.17

* National Bureau of Standards recommended value.

IV. Discussion of Results

It will be noted that, in most cases, the values obtained by the proposed method are slightly higher than those obtained by the older method. This tendency toward high values can be attributed, in part, to a trend toward slightly low results by the alternative procedure. This is more or less to be expected when the many separations involved in the former method are considered.

In no case was it possible to change the weight of the triple acetate residue more than a few tenths milligram by repeated washings with the alcoholic wash, indicating that no uncombined reagent was present unless occluded by the residue. This is extremely doubtful at this concentration and close control of temperature.

[8] Alcohol will precipitate hydrated aluminum perchlorate from the sample solution unless this contaminant is previously removed with the reagent. For a discussion of the formation of the hydrated salt, see D. Dobroserdov, "Preparation and Properties of Aluminum Perchlorate Containing Fifteen Molecules of Water," *Ukrain. Khem. Zhur.*, 2, 109–18 (1926).

V. Optimum Conditions for Precipitation of Sodium as Sodium Uranyl Zinc Acetate

Much of the literature covering the precipitation of sodium as sodium zinc uranyl acetate is misleading to the extent that it implies rather stringent conditions for its precise and accurate determination. Many contradictory statements relating to temperature control, precipitation limits, volume of sample solution, etc., were found. For this reason, a rather extended study was made to determine the optimum conditions for the precipitation of the salt, taking into consideration the fact that, in the present instance, acid solutions heavily charged with perchlorate salts are used.

(1) Effect of Sample Volume

Practically every previous investigator has specified that the volume of sample solution previous to precipitation be held to a minimum; in some cases, a volume of one milliliter was specified as the absolute maximum (see footnotes 1 (*b*), 2, 5, and 9). Churchill, Bridges, and Miller,[6] working with highly acid solutions, specified 5.0 ml. volumes. The use of the method on aqueous solutions of the alkali chlorides (obtained after removal of the elements which interfere in the ordinary course of analysis) over a period of eighteen months indicated that the use of volumes as high as 5.0 ml. were permissible and, for convenience, the latter volume was established as standard for routine analyses.

In an effort to determine whether the reaction was the same when working with acid solutions with a high percentage of foreign perchlorates, a series of samples, each containing 2.38 mg. Na_2O, were decomposed in the manner described, and were transferred to 30-ml. beakers. Each was adjusted to the specified volume and brought to equilibrium at the temperature specified. Precipitation with 20 ml. of the reagent (also at 22°C) followed, and the solutions were allowed to digest for 30 minutes at the prescribed temperature. The remainder of the analysis was carried out as in the experimental procedure. Results are given in Table II.

None of the trials showed an appreciable loss in weight when digested for 15 minutes with 10.0 ml. of the alcoholic wash. This points toward an occlusion of the perchlorates in volumes below

[9] C. C. Miller and Florence Traves, "Determination of Sodium and Potassium in Insoluble Silicates," *Jour. Chem. Soc.* [London], 9, 1390–94 (1936).

TABLE II

Volume of sample (ml.)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
1.0*	2.38	2.59	+0.21
2.0*	"	2.58	+ .20
3.0	"	2.50	+ .12
4.0	"	2.40	+ .02
5.0	"	2.38	± .00
6.0	"	2.36	− .02
7.0	"	2.20	− .18
8.0	"	2.02	− .36
10.0	"	1.97	− .41

* Perchlorates crystallized from solution upon cooling to specified temperature.

4 ml. or to a contamination of the residue by potassium perchlorate, which would be only slightly soluble in the wash solution. Verification of these premises was obtained by precipitation of like amounts of the alkali metal from aqueous solutions of NaCl in volumes varying in the same order as those named before, *i.e.*, quantity of reagent, temperature, and period of digestion being held constant. Volumes below 7 ml. showed an excellent agreement with the expected results, the greatest deviation from the true Na_2O value being 0.01 mg. Volumes of 7 ml. or more showed a decided reduction in percentage precipitation.

From these data, it is apparent that volumes of less than 4 ml. tend to give appreciably high results, while with the initial volumes greater than 6 ml. the reverse is true under the conditions specified. The fact that volumes of 1 to 5 ml., inclusive, are permissible when working with aqueous solutions is also of interest.

(2) Effect of Temperature

Knowles and Redmond,[1(b)] Knowles,[10] and others[11] have indicated that variations in temperature during the period of precipitation are to be avoided because of the likelihood of erratic results, if such variations are more than 1 or 2 degrees. Caley and Foulke,[12] using magnesium uranyl acetate as a precipitant, caution against temperatures higher than 20°C during any part of the precipitation period because of incomplete precipitation at higher temperatures; Dobbins and Byrd[13] state that sodium zinc uranyl acetate is definitely soluble in the reagent at temperatures above 20°C. Barber and Kolthoff[2] state that the solubility is suppressed by an excess of the reagent.

To determine the effect of variations in temperature, a series of samples, with a sodium oxide content of 2.38 mg., were decomposed as previously described. Each sample was adjusted to 5.0 ml. volume and was brought to equilibrium at the desired temperature. Precipitation with 20 ml. of the precipitant at the same temperature was followed by a 30-minute digestion at the temperature demanded by the trial in question. The solutions were filtered, and the analysis was completed, as described. Results of the trials are shown in Table III.

TABLE III

Sample No.	Temperature of precipitation (°C)	Temperature of filtration (°C)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
1	10	10	2.38	2.41	+0.03
2	20	20	"	2.39	+ .01
3	30	30	"	2.38	± .00
4	40	40	"	2.38	± .00
5	50	50	"	1.86	− .52
6	20	30	"	2.38	± .00
7	20	40	"	2.28	− .10
8	20	50	"	1.98	− .40
9	30	20	"	2.48	+ .10
10	40	20	"	2.60	+ .22
11	50	20	"	2.80	+ .42

This series of trials established several interesting facts, *viz.*, (1) up to and including 40°C, precipitation was complete in 30 minutes when the temperature of precipitation and filtration was held constant; (2) an increase of 10°C between time of precipitation and filtration had no bearing on the degree of precipitation (sample No. 6); and (3) as shown by the results obtained on samples Nos. 9 through 11, inclusive, a decrease in temperature between time of precipitation and filtration leads to plus errors of some magnitude.

It was observed throughout this series that the rate of precipitation was a function of the temperature, the salts forming more rapidly in the colder solutions. It is quite possible that complete precipitation of the sodium in sample No. 5 would have taken place if a longer period of digestion had been allowed.

[10] Private communication.

[11] O. M. Smith and Herbert Blair, "Colorimetric Determination for Direct Determination of Sodium," *Proc. Okla. Acad. Sci.*, **13**, 33–35 (1932).

[12] E. R. Caley and C. W. Foulke, "Gravimetric and Colorimetric Method for the Determination of Sodium," *Jour. Amer. Chem. Soc.*, **51** [6] 1664–74 (1929).

[13] J. T. Dobbins and R. M. Byrd, "Volumetric Method for Sodium," *ibid.*, **53** [9] 3288–91 (1931).

The first portion of this series, samples Nos. 1 through 8, showed no further loss in weight when digested with an additional 15.0 ml. of the wash solution for a 15-minute period. Samples Nos. 9 through 11, however, showed losses of 0.4, 10.0, and 21.0 mg. in terms of the triacetate salt after repeated washings. This indicates that a crystallization of the reagent, which is only partially soluble in the volume of wash solution used, had taken place and that no appreciable quantity of the reagent has been occluded by the precipitate. Both of these conditions are to be expected, for the precipitant was saturated with the sodium salt and the reagent at the temperature of precipitation, and precipitation was relatively slow at the higher temperatures.

The conclusion must be drawn that a rough temperature control is desirable for the complete precipitation of the salt without contamination with the reagent. Increases in temperature, in the order of a few degrees, between time of precipitation and filtration are permissible, but decreases in temperature are not to be tolerated, despite the fact that the foreign salts can be removed by protracted washing. It has also been established that the rate of precipitation is more rapid in the cold.

(3) Precipitation Limits

The data presented by previous investigators covering the determination of sodium as the triacetate show a decided divergence of opinion as to the upper precipitation limits of the method or methods. Knowles and Redmond[1(b)] present data to show that precision and accuracy do not suffer when as much as 10.7 mg. Na_2O are present. Glaze[5] and Caley and Foulke[12] set 10.8 mg. as the upper limit; Churchill, Bridges, and Miller[6] state that 10.0 mg. is maximum. Overman and Garrett[14] show slightly low results when working with 10.0 mg. Na (13.2 mg. Na_2O). Because some feldspars have a sodium content approaching the apparent upper limit, a series of trials varying in sodium oxide content from 6.44 to 16.65 mg. was treated in the manner previously outlined. Results are shown in Table IV.

It is at once apparent that the upper precipitation limit lies between 11.8 and 12.6 mg. Na_2O under the described conditions of precipitation. This is outside the range of commercial feldspars, working with 100 mg. samples, and it can be safely predicted that no difficulty arising from an excessive quantity of this alkali metal will be encountered in the analysis of this material.

TABLE IV

Sample No.	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
1	6.44	6.44	±.00
2	7.51	7.49	−.02
3	8.58	8.59	+.01
4	9.66	9.66	±.00
5	10.73	10.73	±.00
6	11.80	11.80	±.00
7	12.76	12.64	−.12
8	13.95	13.63	−.32
9	15.02	14.64	−.38
10	16.03	15.55	−.48
11	16.65	15.79	−.86

(4) Period of Digestion

To determine the effect of the time of digestion upon the completeness of precipitation, a series of trials was conducted to determine both the minimum period of digestion to effect complete precipitation and the effect of long periods of digestion between precipitation and filtration. Each of the samples, containing 5.12 mg. Na_2O, was treated in the usual manner, precipitating and filtering at a temperature of 26°C. Table V is indicative of the results obtained.

TABLE V

Time of digestion (minutes)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
10	5.12	4.95	−0.17
15	"	5.10	−0.02
20	"	5.12	±0.00
30	"	5.12	±0.00
60	"	5.12	±0.00
8 (hr.)	"	5.11	−0.01

The results indicate that a 15-minute digestion period is sufficient to precipitate sodium oxide completely under the described conditions.

(5) Sample Solution—Reagent Ratio

From the data given in the tables, it must be assumed that the minimum sample solution-reagent ratio is 1 to 4 and that this ratio is sufficient to precipitate sodium completely (1) in the range found in commercial feldspars, (2) in sample volumes of 5 ml., and (3) in digestion periods of 30 minutes at room temperature. With the exception of the work of Chen,[15] who used a sample

[14] O. R. Overman and O. F. Garrett, "Determination of Sodium; Removal of Phosphorus before Determining Sodium by the Uranyl Zinc Acetate Method," *Ind. Eng. Chem., Anal. Ed.*, **9** [2] 72–73 (1937).

[15] Graham Chen, "Microchemical Determination of Sodium by Uranyl Zinc Acetate Method and Titration of Uranium with Cadmium as Reductant," *Jour. Lab. Clin. Med.*, **21**, 1198–1202 (1936).

solution-reagent volume of 1 to 3 when working with alcoholic solutions containing 0.04 to 0.2 mg. Na, every investigator has insisted upon a ratio of at least 1 to 10 and, in some cases, a ratio of 1 to 20 has been specified.

Trials with smaller volumes of reagent, always keeping the volume of sample solution constant at 5 ml. and period of digestion at 30 minutes, invariably produced low results. It was found that sample solution-reagent ratios in excess of 1 to 4 always gave good results, regardless of the extent of this excess up to and including a ratio of 1 to 25.

(6) Effect of Acidity of Sample Solution

Because practically all of the previous work has been done on aqueous solutions, it seemed advisable to determine the effect of varying acidity of the sample solution, prior to precipitation, upon the accuracy of the method. A series of samples, varying in total acidity in terms of $HClO_4$, was therefore treated in the described manner. The results are shown in Table VI.

The data given indicate that $HClO_4$ should be held below 1 ml. per 5 ml. volume, though higher concentrations do not show a large deviation from the true value.

The precision and accuracy attained in this series is difficult to reconcile with the appearance of the individual residues. The crystal structure was, by visual observation, much different

TABLE VI

Percentage $HClO_4$	Temp. of sample solution* (°C)	Temp. of reagent (°C)	Temp. of precipitation (°C)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
20	50	22	22	4.60	4.62	−0.02
40	50	22	22	"	4.63	− .03
60	50	22	22	"	4.65	− .05

* It was found necessary to increase the temperature to hold perchlorates in solution. Upon addition of the reagent at 22 °C, the temperature of the total solution dropped immediately to 26 °C.

from that encountered in previous trials and, upon microscopic examination, the residues were found to be a heterogeneous mass of crystals of no definite configuration. It is never necessary, however, to have an acid concentration of more than 0.2 *N* in regular routine practice so the likelihood of difficulty from this score is rather remote.

(7) Effect of Foreign Salts

Of the constituents possibly present in feldspar, attention has been drawn to the interference of phosphorus (see footnotes 2, 12, 14, 16, and 17 through 20), potassium (footnotes 2, 16, and 17), barium,[20] and lithium (see footnotes 9 and 16).

(*a*) *Phosphorus:* Phosphorus was expected to interfere because of the probability of co-precipitation of uranium phosphate with the sodium zinc uranyl acetate. To overcome this interference, Barber and Kolthoff precipitated the PO_4 ion with magnesia mixture.[16] Other investigators have used powdered zinc carbonate,[14] powdered calcium hydroxide,[19] basic zinc acetate,[18] and alcoholic zinc acetate[21] for the same purpose. No data are given, however, to show the extent of this interference without preliminary removal of the phosphorus ion.

TABLE VII

P_2O_5 present (mg.)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
0.1	2.47	2.47	±0.00
0.2	2.55	2.55	±0.00
0.3	2.63	2.65	+0.02
0.5	2.81	2.82	+0.01
1.0	3.25	3.25	±0.00

A series of phosphorus-free samples, each having a sodium oxide content of 2.37 mg., was treated with successively larger portions of a solution of $NaHPO_4 \cdot 4H_2O$, decomposed with HF and $HClO_4$, and the analysis was carried out as before. Table VII is indicative of the results obtained.

From this tabulation, it is readily apparent that phosphorus, in the amounts found in feldspar, causes no interference with the determination of sodium as the triple acetate. This is difficult to reconcile with the findings of the investigators cited previously or with the work of Gutzeit,[22]

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[16] H. H. Barber and I. M. Kolthoff, "Gravimetric Determination of Sodium by the Uranyl Zinc Acetate Method: II, Application in the Presence of Rubidium, Cesium, Potassium, Lithium, Phosphate, or Arsenate," *Jour. Amer. Chem. Soc.*, **51** [11] 3233–37 (1929).

[17] C. S. Piper, "Determination of Sodium and Potassium," *Jour. Proc. Australian Chem. Inst.*, **4** [1] 18–26 (1937).

[18] R. A. McCance and H. L. Shipp, "Colorimetric Determination of Sodium," *Biochem. Jour.*, **25**, 449–56 (1931).

[19] A. M. Butler and Elizabeth Tuthill, "Application of the Uranyl Zinc Acetate Method for Determination of Sodium in Biological Materials," *Jour. Biol. Chem.*, **93**, 171–80 (1931).

[20] F. Kogler, "Determination of Sodium as Sodium Magnesium Uranyl Acetate," *Angew. Chem.*, **48**, 561–65 (1935).

[21] Istram Rusznyak and Ella Hartz, "New Method for Determination of Sodium in Blood Serum," *Magyar. Orvos. Arch.*, **34**, 186–91 (1933).

[22] Gregoire Gutzeit, "Rapid Method of Qualitative Analysis: I, Some Specific and Special Tests for Common Cations and Anions," *Helv. Chem. Acta.*, **12**, 713–40 (1929).

who used uranium acetate for the qualitative detection of phosphorus.

As further confirmation of this noninterference of phosphorus with the determination of sodium when the alkali salt is precipitated from acid solution, 25 ml. of the sodium acid phosphate solution, each milliliter of which was equivalent to 0.1 mg. P_2O_5 and 0.086 mg. Na_2O, were evaporated to 5 ml., two drops of $HClO_4$ were added, and the sodium was precipitated as before with zinc uranyl acetate. After digestion and filtration, the residue was found to weigh 106.5 mg. against a calculated value of 106.7 mg. This result is equivalent to 2.15 mg. Na_2O, a value identical with that present originally.

(*b*) *Potassium:* Data presented by previous workers (see footnotes 2, 11, 12, 16, and 17) indicated that potassium, in the amounts found in feldspars, will not interfere with the complete precipitation of sodium as the triacetate. This was confirmed in the present investigation, potassium oxide to the extent of fifteen times the sodium oxide content introducing no deleterious effect. This is, perhaps, the maximum alkali ratio to be found in feldspars and only rarely in materials from highly kaolinized deposits.

(*c*) *Barium:* Barium has been found to be present in certain feldspars in appreciable amounts. Most of the data presented previously indicate that this cation does not interfere, if present to the extent of 40 to 200 mg. per determination, provided sulfuric acid is absent (see footnotes 2 and 12). The earlier trials, however, were conducted using aqueous solutions of barium chloride as the contaminant. Kogler[20] stated definitely that barium, present as perchlorate, interfered in *any* amount.

To determine the extent of this interference, samples of barium-free feldspars were salted with a standard solution of barium chloride, the sample was decomposed with HF and $HClO_4$, and the analysis was completed in the usual manner. Up to and including 5% BaO, the upper limit to be found in commercial feldspars, no interference was evidenced. The anomalous results reported by Kogler may have been due to contamination of the precipitant by sulfates.

(*d*) *Lithium:* Lithium forms a complex with zinc uranyl acetate, and the reagent has been used for the gravimetric determination of this alkali metal in lepidolite after a preliminary removal of sodium with butyl alcohol and ethyl acetate, though conditions for complete precipitation are critical.[23] Insley and Glaze[24] state that sodium and lithium uranyl acetates form solutions of solid miscibility. Caley and Foulke,[12] working with the magnesium salt, have shown that the presence of 6.46 mg. Li_2O, in a sample containing 13.2 mg. Na_2O, causes an error of +0.4 mg. Na_2O, if the entire residue is assumed to be the sodium salt. Lithium, if present at all in feldspars, will be found in such small amounts that, in the ordinary course of analysis, no interference from this source need be anticipated.

A series of samples, each containing 4.90 mg. Na_2O, was treated with known amounts of LiCl, decomposed with HF and $HClO_4$, and the analyses were completed in the usual manner. The results are shown in Table VIII.

TABLE VIII

Li_2O present (mg.)	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
0.2	4.90	4.92	+0.02
0.4	"	4.94	+0.04
0.6	"	4.98	+0.08
0.8	"	5.00	+0.10
1.0	"	5.03	+0.13

The data indicate that lithia in the quantities possible in feldspar will not introduce an appreciable error in the estimation of sodium oxide as the triacetate.

(8) Application to Other Materials

Inasmuch as the work on feldspar indicated that the procedure, as outlined, might prove useful in the analyses of other ceramic materials of a similar nature as to chemical composition, trials were conducted on a series of glasses, china clays, and Cornwall stones. In all cases, the upper precipitation limits of the method were taken into consideration as were the possible sources of interference other than those investigated.

The original decomposition of these samples was identical with that used in the work on feldspar, and in no case was there any difficulty in attaining a complete decomposition of the sample. The results of a few scattered analyses are given in Table IX.

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[23] C. C. Miller and Florence Traves, "New Method for Quantitative Separation of Lithium, with Reference to Its Determination in Insoluble Silicates," *Jour. Chem. Soc.* [London], **9**, 1395–99 (1936).

[24] Herbert Insley and F. W. Glaze, "Some Optical and Crystallographic Properties of Alkali Uranyl Acetates," *Bur. Stand. Jour. Research*, **12**, 471–74 (1934).

TABLE IX

Material	Na_2O present (mg.)	Na_2O found (mg.)	Error (mg.)
Soda lime glass, No. 80	8.33*†	8.30	−0.03
Opal glass, No. 91	8.48*	8.46	−0.02
Cornwall stone	4.20	4.22	−0.02
China clay	0.24	0.22	−0.02

* National Bureau of Standards recommended value.
† 50.0 mg. sample used.

The results indicate that the method might be useful in analyses of silicates other than feldspar.

VI. Summary

Sodium can be determined in solutions weakly acid with perchloric acid by precipitation as the sodium salt of zinc uranyl acetate without regard to aluminum, iron, titanium, phosphorus, calcium, barium, or potassium. Lithium interferes only slightly.

A rough control of temperature during the digestion of the precipitate is desirable as is the control of the volume of the sample solution prior to precipitation. A sample solution-reagent ratio of 1 to 4 is sufficient for the complete precipitation of approximately 12.0 mg. Na_2O in 5.0 ml. of solution at room temperature, using a 30-minute period for the digestion of the precipitate.

A major advantage of the method is found in the elimination of the use of reagents which might carry sodium as an impurity, thereby making the use of "blank" corrections unnecessary. The method as outlined requires far less personal attention than do the alternative procedures, and the reagent cost is relatively low. The over-all precision and accuracy is somewhat better than that obtainable in routine analyses with the former procedures, and results are derived in a shorter period of time.

If potassium as well as sodium is desired, the method offers little or no advantage over the former procedure.[25]

Acknowledgments

The author is indebted to Thomas Carson, Jr., for much of the analytical data and to Robert A. McNees for confirmation of some of the results, particularly in regard to the noninterference of phosphorus. Thanks are extended to H. B. Huddle for the loan of certain of the temperature-control equipment and to the Consolidated Feldspar Corporation for the privilege of conducting this investigation.

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[25] A method for the semidirect determination of potassium after a decomposition of the sample identical with that used in the present method is available. This will be discussed in a later paper.

USE OF BROMATE IN VOLUMETRIC ANALYSIS: VII, POTENTIOMETRIC TITRATION OF HYDROXYQUINOLINE *

BY G. FREDERICK SMITH AND R. L. MAY

ABSTRACT

The potentiometric titration of 8-hydroxyquinoline and the metallic inner complexes, *i.e.*, magnesium oxyquinolate, is described, using direct titration with a standard bromate solution of the hydrochloric acid solution of the hydroxyquinoline or its derivatives with particular reference to magnesium oxyquinolate. Potentiometric procedures for direct determination have been developed using the electrode system, platinum–nickel. This procedure involves the use of the monometallic, platinum-platinum electrode pair and the electron beam sectrometer as the recording instrument, which has a distinct advantage of speed and equal accuracy over previous electrometric titrations. A series of experimental analyses has been carried out both on the hydroxyquinoline and its magnesium salt. The procedure is well adapted to routine plant control analyses, and a separation of calcium prior to the determination of magnesium is not required.

I. Introduction

The volumetric determination of hydroxyquinoline (oxime) was first suggested by Berg.[1] The well-known Koppeschaar reaction[2] used in the determination of phenols was applied. The procedure of Berg is probably most frequently used in the volumetric determination of magnesium, although many other procedures for the determination of metals following their precipitation as quinolate inner complexes are known. The determination of magnesium applies the principle of the precipitation of magnesium hydroxyquinolate from ammoniacal solution. The excess precipitant is washed out, and the precipitate is dissolved in hydrochloric acid. An excess of bromate-bromide mixture is added, forming the 5,7 di-brom hydroxyquinoline which requires

* Contribution from the Chemical Laboratories, Univ. of Illinois, Urbana, Ill. Received March 10, 1938.

[1] Richard Berg, "Evaluation of Quinosol Preparations," *Pharm. Ztg.*, **71**, 1542 (1926).

[2] W. Koppeschaar, "Maassanalytische Bestimmung des Phenols," *Z. anal. Chem.*, **15**, 233 (1876).

eight equivalents of oxidant per mol. of magnesium oxide. The excess bromate-bromide mixture is generally determined iodometrically. The present paper has for its objective the description of the direct determination of magnesium hydroxyquinolate potentiometrically using the polarized Pt–Pt electrode system.

II. Previous Work

The direct titration of hydroxyquinoline potentiometrically was described by Atanasiu and Velculescu,[3] who used the platinum-nickel bimetallic electrode pair. The titration of hydroxyquinoline was also studied potentiometrically by Kitajima.[4] The present use of the polarized Pt-Pt electrode pair and the determination of the equivalence point in the bromination of quinoline is new, and the use of the electron beam sectrometer, first described by Smith and Sullivan,[5] has been shown to serve admirably for this purpose. The determination of magnesium oxide, following the precipitation of the corresponding oxyquinolate described by Redmond and Bright,[6] has been used to check the validity of the potentiometric equivalence-point determination. A study of several metals added as catalyst will be shown to increase materially the velocity of the reaction. The most complete reference to the use of hydroxyquinoline in analytical procedures is supplied by Berg.[7]

III. Reaction Velocity and the Influence of Metal Ions as Catalysts

The titration of a hydrochloric acid solution of oxyquinoline in the presence of potassium bromide by the use of sodium bromate is not sufficiently rapid for direct titration at room temperature. At 50°C, the reaction is still sluggish but satisfactory. Ferric chloride, cupric chloride, magnesium chloride, and osmic acid were found to increase the reaction velocity materially. The comparison of results is shown in Table I.

Note: The present paper was read at the Mid-West Regional Meeting, American Chemical Society, Omaha, Neb., 1937. The electron beam sectrometer is manufactured by the G. Frederick Smith Chemical Co., Columbus, Ohio. The same instrument with some modification is also manufactured and distributed by the Fisher Scientific Co., Pittsburgh, Pa. The authors are indebted to the Fisher Scientific Co. for supplying a set of their modification of the electron beam sectrometer for this work.

Table I

Direct Determination of Hydroxyquinoline in Hydrochloric Acid Solutions of Potassium Bromide at 50°C

Hydrochloric acid present: 10 ml. (sp. gr. 1.18)/100 ml. solution
Potassium bromide: 5 ml. of 10% solution/100 ml.
Hydroxyquinoline: 10 ml. of 1% solution/100 ml.
Pt-Pt polarized reference electrodes used throughout.

(Ml.)	Catalyst	0.4826 *N* $NaBrO_3$ (ml.)	Time of reaction (min.)
	None	7.76	5
	"	7.75	5
0.1	10% $FeCl_3$	7.76	3
0.25	2 " $CuCl_2$	7.78	3
10	2 " $MgCl_2$	7.76	3
0.1	0.01 *N* OsO_4	7.76	2.5

Upon examination of the data of Table I, it will be observed that the reaction time is twice as rapid with osmic acid as the catalyst. The other catalysts examined were almost as effective, and magnesium, in sufficient quantity, is equal in effect to minute amounts of the ferric and cupric ions.

IV. Potentiometric Characteristics of Equivalence-Point Determination

The polarized Pt-Pt electrode pair and the cathode-ray tube-sector shadow indication of the equivalence point are ideal for following the direct bromination of hydroxyquinoline. The addition of the first 80 to 90% of the required bromate solution at 50°C is accompanied by practically no tendency of the cathode-ray tube-sector shadow to close if the oxidant is added fairly slowly. The sector shadow, at the start of the titration, is adjusted to be ready to close with the first small increase in potential with the polarizing current, which is flowing continuously. During the addition of the last portion of oxidant, the sector shadow will close a fraction of a second and then rapidly resume the starting position. During the addition of the last few drops, the sector

[3] J. A. Atanasiu and A. J. Velculescu, "Potentiometrische Bestimmung von o-Oxychinolin mittels Bromierung," *Z. Anal. Chem.*, **97**, 102 (1934).

[4] Ippei Kitajima, "Studies on the Potentiometric Determination of Organic Precipitates: I, Estimation of 8-Hydroxyquinoline, Anthranilic Acid, and the Metals Precipitable by These Two Compounds," *Jour. Chem. Soc. Japan*, **55**, 889 (1934).

[5] G. F. Smith and V. R. Sullivan, "Electron-Beam Sectrometer: a Line-Operated Vacuum-Tube Titrometer for Potentiometric Titrations with Cathode-Ray Tube Replacement of the Micro-Ammeter," *Jour. Soc. Chem. Ind.*, **56**, 104T (1937).

[6] J. C. Redmond and H. A. Bright, "Determination of Magnesium in Portland Cement and Similar Material by the Use of 8-Hydroxyquinoline," *Bur. Stand. Jour. Research*, **6** [1] 113–20 (1931); R.P. 265; *Ceram. Abs.*, **10** [4] 304 (1931).

[7] Richard Berg, "Oxin," Das o-Oxychinolin, Vol. 34. F. Enke, Stuttgart, Germany, 1935.

shadow closes for 5 to 10 seconds and then opens to show a full shadow. After the addition of the first drop of the excess of oxidant, the sector closes and remains closed for a full minute or more. The important advantage to be gained in the use of the types of potentiometric equipment mentioned is that the reaction can be followed as fast as possible inasmuch as a vivid, instantaneous indication of the exact reaction velocity is constantly provided. Other potentiometric equipment is obviously less satisfactory.

V. Comparison of Gravimetric and Volumetric Determination of Magnesium

It is now requisite that the end-point, arbitrarily selected as described, be verified using known amounts of a hydroxyquinoline inner complex salt. The method of Redmond and Bright[6] was employed for the determination of magnesium, first gravimetrically and then by bromate oxidation, using the same samples for each analysis. Known volumes of the magnesium chloride solution were precipitated in the presence of ammonia by excess of hydroxyquinoline. The precipitates were filtered in fritted glass crucibles, washed, dried at 130° to 140°C, and weighed. The precipitates were then dissolved in excess hot 2 *N* hydrochloric acid, 10 milliliters of 10% potassium bromide solution were added after dilution to 100 milliliters, heated to 50° to 60°C, and titrated with standard bromate solution as described. The bromate solution was standardized using National Bureau of Standards arsenious oxide, and the mean value from six closely agreeing determinations were taken. The results are shown in Table II.

NOTE: The publication of the present data has been delayed to allow time to try the method in student hands. A large number of students have applied the method successfully with results equal in accuracy to those reported in connection with this work. E. W. Koenig, Consolidated Feldspar Corp., Erwin, Tenn., has adopted the method for routine plant control analyses.

It will be seen from the values of Table II that the agreement between the results, both by gravimetric and volumetric procedure, on the average, is accurate to within 3 parts per thousand. Ten additional determinations of the same volume of this magnesium solution in which the magnesium hydroxyquinolate was filtered, washed, dissolved, and titrated, without intermediate gravimetric determination gave an average determination of 36.3 milligrams of magnesium oxide which duplicates the gravimetric determination of Table II. It is thus seen that, by working with moderate amounts of magnesium,

TABLE II

SIMULTANEOUS DETERMINATION OF MAGNESIUM AS HYDROXYQUINOLINE, GRAVIMETRICALLY AND BY DIRECT BROMINATION

10.00 ml. of 2% solution of magnesium chloride (approx.) in each analysis.
Gravimetric determinations of MgO after drying magnesium hydroxyquinolate at 130° to 140°C.
Temperature during titration: 50° to 60°C.
Osmic acid used as catalyst.
Solutions 10% by volume of hydrochloric acid.

$Mg(C_9H_6ON)_2$ (g.)	0.4826 *N* $NaBrO_3$ (ml.)	Magnesium oxide		
		Gravimetric (mg.)	Volumetric (mg.)	Difference (mg.)
0.2790	14.82	36.1	36.0	−0.1
.2795	14.91	36.1	36.3	+0.2
.2827	14.90	36.5	36.2	−0.3
.2823	14.90	36.4	36.2	−0.2
.2826	14.93	36.5	36.3	−0.2
.2820	15.00	36.5	36.5	±0.0
.2811	14.88	36.3	36.2	−0.1
.2809	14.89	36.2	36.2	±0.0
.2803	14.88	36.2	36.2	±0.0
.2807	14.85	36.2	36.1	−0.1
.2819	14.90	36.4	36.2	−0.2
Av.		36.3	36.2	−0.1

the hydroxyquinolate does not occlude appreciable quantities of the precipitant. This fact indicates that by using excess of known strength hydroxyquinolate precipitant, the determination could be based upon the determination of this excess without the necessity for the solution of the precipitate.

VI. Summary

(1) A procedure for the direct titration of hydroxyquinoline, bromometrically based upon the direct titration of its solution in hydrochloric acid in the presence of bromide and using bromate as oxidant, has been described.

(2) The application of the Pt–Pt, polarized, monometallic electrode system and of the newly developed thermionic-titration equipment, now commercially available, has been described.

(3) The influence of ferric, cupric, and magnesium ions as catalyst for the reaction of bromination has been studied; osmic acid was found to be the best catalyst of a long list examined.

(4) The new procedure has been found to agree well with the best gravimetric procedure in the case of the determination of magnesium.

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January, 1939
18—1

Abrasives

Carbides ground in half the time. N. N. Shepherd. *Amer. Machinist*, **80**, 573–76 (1936).—The proper technique of grinding and the selection of machinery are described at length. Only special silicon carbide wheels should be used for grinding carbide tools; the wheels should be a rather soft grade. The correct wheel speed is about 5000 ft./min. on the surface. M.H.

Cleaning steel castings. P. A. Dougher. *Trans. Amer. Foundrymen's Assn.*, **8** [1] 496–506 (1937).—The selection of proper equipment, the testing of chipping hammers, and the steel used for pneumatic chipping are described. D. gives the results of grinding-wheel tests and a method for keeping the peripheral speed of the wheels within certain limits as the wheels wear. The various apparatus used for abrasive cleaning are discussed, and it is hoped that a water method can be used for cleaning castings. H.E.S.

Determination of the grinding power of various abrasives in comparison with diamond. W. Dawihl, K. Schröter, and M. Stockmayer. *Z. Ver. Deut. Ing.*, **80** [33] 1001–1003 (1936).—Comparative values established for diamond powder used for working diamond dies and hard-metal dies are as follows:

	Diamond dies	Hard-metal dies
Diamond	10	10
Boron carbide	0.5	6
Crystallized boron	"	4.8
Silicon carbide	"	2.2

The hardnesses of diamond, boron carbide, and silicon carbide are 9.92, 9.32, and 9.13, respectively. For practical purposes, diamond is so superior that the use of other materials in making drawing dies is not economical. See "Process— ," *Ceram. Abs.*, **16** [10] 292 (1937). M.H.

Economical die maintenance assured by modern machines. F. B. Jacobs. *Steel*, **101** [6] 36–38 (1937).—Precision grinding is relied on to a great extent in keeping dies for stamping various building products in proper working condition. It is better practice to grind dies frequently, removing only a few thousandths of an inch at each grind, than to wait until the dies are unduly dull, necessitating the removal of 0.010 to 0.030 in. to renew the cutting edges. Modern equipment, including up-to-date grinding wheels, keeps maintenance costs on dies from becoming prohibitive. Illustrated. H.E.S.

Etching method for determining the structure of melted boron carbide. W. Dawihl and R. Flüshöh. *Z. Metallkunde*, **29**, 135–37 (1937); *Brit. Chem. Abs.–B*, **56**, 1206 (1937).—Commercial B_4C can be etched in fused KNO_3; melted B_4C (Norbide) appears to consist of two constituents: *A*, having irregular grain boundaries and developing riffles on prolonged etching, and *B*, having well-defined grain boundaries showing no riffles even after very prolonged etching. It is suggested that B_4C is stable only at high temperature and decomposes into graphite and a carbide with a lower C content on heating.

Grinding and polishing paper rollers. E. Schulte. *Papier-Fabr.*, **34**, 270–72 (1936).—Silicon carbide wheels are recommended for cast, stone, and bronze rollers. Silicon carbide in artificial resin is desirable for removing scratch formations from bronze rollers; abrasives not too fine are to be used on rubber rollers. Wet grinding is recommended for the harder rubber rollers. D.A.B.

Improved cleaning, brushing, polishing, and grinding agents for the metal industry. F. Ohl. *Oberflächentech.*, **15** [17] 169–70 (1938).—O. reviews modern practice and gives recipes for treating different metals. M.H.

Metallic surfaces. E. Werner. *Oberflächentech.*, **15** [18] 179–80 (1938).—W. reviews the character of natural and treated surfaces on metals, grinding and polishing methods and agents, and recipes of varnishes and picklers for obtaining certain surface and decorative effects. M.H.

Production of highly dispersed alumina suitable for polishing. K. J. Manuilov and F. I. Zimbal. *Legkie Metally*, **6** [10] 8–15 (1937); abstracted in *Chem. Zentr.*, **1938, I**, 4705.—An aluminate solution was used as raw material and was decomposed at 50°. The size of the precipitated particles was uniform and varied between 5 μ and 30 μ according to the degree of decomposition. After 2 hr. calcining at 1300° a uniform product composed

chiefly of the alpha modification (corundum) was obtained. The corundum was ground for 20 hr. in a porcelain mill to obtain finer material (1 to 1.5 μ). M.V.C.

Sharpening wheels. V. H. ERICSON. *Amer. Machinist*, **80**, 988–90 (1936).—A table is compiled for the correct selection of sharpening wheels for carbon, high-speed, and Stellite tools. The peripheral speed should be 4500 to 6000 ft./min. for dry grinding and 5000 to 6000 ft./min. for wet grinding. The proper grinding procedure for different kinds of tools is briefly described. M.H.

Testing corundum and silicon carbide. KAEMPFE. *Ber. Deut. Keram. Ges.*, **18** [7] 321 (1937).—Artificial corundum should be tested for gain on oxidation, titanium content (not greater than 2%), and if possible thermal expansion of the unfired material. The solubility of SiC in alkali should not be greater than 1%. The breakdown of SiC is due to catalysts from clay, etc., which oxidize part of the SiC to SiO_2 and are then reoxidized by the oxygen from the atmosphere. E.J.V.

PATENTS

Abrading appliance. K. H. BOWEN (Columbian Rope Co.). U. S. 2,131,309, Sept. 27, 1938 (May 14, 1938). A disk-like body for an abrading member comprises a lamination consisting essentially of a sheet of reinforcing material, a layer of promiscuously disposed fibers covering the side surface of the sheet with portions of the fibers projecting through the sheet, and a binder uniting the fibers and reinforcing sheet in a unitary mass.

Abrading reamer. JOSEPH DISCO. U. S. 2,135,884, Nov. 8, 1938 (Dec. 10, 1934).

Abrading roller. P. G. AULSON (Aulson Tanning Machinery Co.). U. S. 2,130,409, Sept. 20, 1938 (Jan. 16, 1937).

Abrasive article. MERCER G. FARRAR (Carborundum Co.). Can. 376,840, Oct. 4, 1938 (Jan. 21, 1936). G.M.H.

Abrasive article and method of manufacturing. W. J. TENNANT (Carborundum Co.). Brit. 491,658, Sept. 21, 1938 (March 6, 1937).

Abrasive article and method of manufacturing. N. P. ROBIE (Carborundum Co.). U. S. 2,135,626, Nov. 8, 1938 (Feb. 2, 1937). In a method of making abrasive articles, the steps comprise preparing a suspension of abrasive particles in a solution of a polyvinyl ester in an alcohol and adding a catalyst to cause reaction between the alcohol and the ester, whereby there is formed a solid mass of polyvinyl alcohol containing abrasive particles suspended therein and distributed uniformly therethrough.

Abrasive-coated articles and method of manufacturing. A. ABBEY (Carborundum Co.). Brit. 493,779, Oct. 26, 1938 (April 13, 1937).

Abrasive device. F. O. ALBERTSON (Albertson & Co., Inc.). U. S. 2,132,917, Oct. 11, 1938 (May 9, 1938). An abrasive backing disk comprises a circular member provided with a plane body portion and a centrally located depression for receiving the head of a threaded member.

Abrasive device. J. L. BALLASH (Sterling Grinding Wheel Co.). U. S. 2,133,009, Oct. 11, 1938 (Nov. 16, 1936). An abrasive device comprises a chuck and a segmental grinding ring.

Abrasive device for truing spherical surfaces. G. W. PERSON AND S. F. PRESCOTT (Norton Co.). U. S. 2,130,987, Sept. 20, 1938 (May 27, 1937).

Abrasive drums. DUREX CORP. Brit. 493,985, Nov. 2, 1938 (Nov. 21, 1936).

Abrasive wheel. MERTON B. LANE (Norton Co.). Can. 377,194, Oct. 18, 1938 (Jan. 11, 1937; in U. S., Jan. 14, 1936). G.M.H.

Apparatus for honing. H. R. BERARD AND W. D. MCKEON (Heald Machine Co.). U. S. 2,133,375, Oct. 18, 1938 (Nov. 5, 1936).

Apparatus for sawing, abrading, etc. L. A. WILKIE. Brit. 492,206, Sept. 28, 1938 (May 27, 1937).

Apparatus for use in grinding a member to be of non-cylindrical shape. A. FLOWER. Brit. 491,679, Sept. 21, 1938 (June 19, 1937).

Article of ceramic bonded abrasive material and method of making. L. H. MILLIGAN AND R. H. LOMBARD (Norton Co.). U. S. 2,132,005, Oct. 4, 1938 (Oct. 19, 1936). The method of making an article of ceramic-bonded oxidizable abrasive granular material comprises incorporating in a raw ceramic bond mixture a sufficient amount of a protective reagent which is capable of reacting preferentially with the oxygen within the article and preventing deleterious oxidation of the abrasive grains during the firing operation, shaping an article from a mixture of the grains and bond, and firing it to develop the bond.

Artificial pulp-grinding stone and method of making. H. P. SCHEEL, JR. U. S. 2,134,738, Nov. 1, 1938 (Oct. 12, 1936; renewed Jan. 17, 1938).

Attachment for grinding machines. R. D. STREBY (Timken Roller Bearing Co.). U. S. 2,133,232, Oct. 11, 1938 (Feb. 21, 1938).

Bonded abrasive articles. W. J. TENNANT (Carborundum Co.). Brit. 491,655, 491,659, and 491,660, Sept. 21, 1938 (March 6, 1937).

Buff construction. L. W. KREILICK AND H. R. TAYLOR. U. S. 2,130,850, Sept. 20, 1938 (Sept. 15, 1937).

Buffing compound. W. K. GRIESINGER (Atlantic Refining Co.). U. S. 2,130,128, Sept. 13, 1938 (July 9, 1938). A buffing compound comprises a substantially homogeneous solid mixture of water-dispersible petroleum sulfonate soap and finely divided abrasive, the sulfonate soap softening at temperatures of from about 125° to about 175°F and being substantially resistant to charring at temperatures of about 400° to 500°F.

Buffing or polishing wheel. E. W. HALL. U. S. 2,132,532, Oct. 11, 1938 (Sept. 16, 1937).

Buffing wheel. L. W. KREILICK AND H. R. TAYLOR (Yerges Mfg. Co.). U. S. 2,130,849, Sept. 20, 1938 (Jan. 13, 1936).

Cam-grinding apparatus. C. J. GREEN (Norton Co.). U. S. 2,132,949, Oct. 11, 1938 (March 10, 1936).

Centrifugal abrading device. A. V. HOLLINGSWORTH (American Foundry Equipment Co.). U. S. 2,135,510, Nov. 8, 1938 (Nov. 14, 1936).

Composite abrasive sheet. A. L. BALL (Carborundum Co.). U. S. 2,129,661, Sept. 13, 1938 (Jan. 13, 1936).

Crankshaft grinder. ELMER FUGLIE AND ORE OELKERS. U. S. 2,130,003, Sept. 13, 1938 (April 30, 1938).

Cylindrical grinding machine. A. G. BELDEN (Norton Co.). U. S. 2,132,924, Oct. 11, 1938 (Jan. 29, 1938).

Device for dressing grinding wheels. HERMANN DANNER (Fortuna-Werke Spezialmaschinenfabrik A.-G.). U. S. 2,133,191, Oct. 11, 1938 (Aug. 20, 1937).

Device for truing curved working surfaces of grinding disks for grinding toothed wheels. ZAHNRADFABRIK FRIEDRICHSHAFEN A.-G. Brit. 490,858, Sept. 7, 1938 (March 9, 1936).

Device for truing or cutting a grinding wheel to allow for clearance angle of the cutting tool to be shaped by the grinding wheel. J. B. HADDEN. Brit. 491,589, Sept. 21, 1938 (Feb. 3, 1937).

Dividing apparatus for grinding machines for grinding toothed wheels, grooved shafts, etc. ZAHNRADFABRIK FRIEDRICHSHAFEN A.-G. Brit. 491,118, Sept. 7, 1938 (Sept. 25, 1936).

Drill-grinding machine. A. A. BAHUAUD. U. S. 2,133,414, Oct. 18, 1938 (Jan. 25, 1937).

Edge trimmer grinder. ERNEST DUNFORD (Landis Machine Co.). U. S. 2,134,751, Nov. 1, 1938 (Sept. 9, 1937).

Forming or shaping grinding or abrasive wheels. S. A. HORSTMANN AND HORSTMAN, LTD. Brit. 492,591, Oct. 5, 1938 (Feb. 22, 1937).

Gear-grinding machine. C. T. GALLOWAY (Gleason Works). U. S. 2,133,386, Oct. 18, 1938 (May 10, 1937).

Grinding or abrading machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 490,776, Aug. 31, 1938 (March 31, 1937).

Grinding or honing of internal cylindrical surfaces. MICROMATIC HONE CORP. Brit. 493,949, Nov. 2, 1938 (Dec. 19, 1936).

Grinding machine. A. L. KRAUSE (Brown and Sharpe

Mfg. Co.). U. S. 2,131,107, Sept. 27, 1938 (April 6, 1937). E. S. MUMMERT-DIXON CO. U. S. 2,132,640, Oct. 11, 1938 (July 18, 1936). FRANZ NEUGART. U. S. 2,130,-021, Sept. 13, 1938 (April 11, 1938). H. F. SMITH. U. S. 2,131,151, Sept. 27, 1938 (June 3, 1938). J. C. WILSON (Safety Grinding Wheel & Machine Co.). U. S. 2,130,823, Sept. 20, 1938 (May 25, 1937).

Grinding machine table reciprocating mechanism. H. S. INDGE (Norton Co.). U. S. 2,132,953, Oct. 11, 1938 (Dec. 31, 1936).

Grinding and polishing machines for hard materials. SPEED SURFACES, LTD. (G. F. Brendel). Brit. 491,610, Sept. 21, 1938 (April 19, 1937).

Grinding railway wheels. W. PILZ. Brit. 491,629, Sept. 21, 1938 (July 20, 1937).

Grinding tool. H. W. KULP (K-D Mfg. Co.). U. S. 2,135,900, Nov. 8, 1938 (March 19, 1935).

Grinding tool for the inner surfaces of cylinders. CARBORUNDUM CO. Ger. 658,329, March 10, 1938 (April 27, 1933); XII/67*a*. 9. Technical details of a grinding tool for grinding the inner surfaces of cylinders are given. D.A.B.

Grinding wheel truing device. H. H. ASBRIDGE (Churchill Machine Tool Co., Ltd.). U. S. 2,130,711, Sept. 20, 1938 (March 21, 1938).

Hone. WILLIAM VANLANDINGHAM. U. S. 2,135,926, Nov. 8, 1938 (March 1, 1937).

Honing machine. A. M. JOHNSON (Barnes Drill Co.). U. S. 2,130,393, Sept. 20, 1938 (July 8, 1936).

Internal grinding machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 491,666, Sept. 21, 1938 (April 1, 1937).

Lapping machine. R. H. LAWSON AND WILLIAM JACKSON (Hemphill Co.). U. S. 2,135,186, Nov. 1, 1938 (Feb. 8, 1937).

Lapping machine and method. G. P. PASSMORE (Westinghouse Electric & Mfg. Co.). U. S. 2,131,638, Sept. 27, 1938 (Jan. 30, 1937; renewed March 9, 1938).

Machine for forming spiral bevel gear cutters. E. C. HEAD (Goddard & Goddard Co., Inc.). U. S. 2,135,894, Nov. 8, 1938 (March 6, 1936).

Machine for grinding articles to predetermined forms. C. DAY. Brit. 491,676, Sept. 21, 1938 (May 31, 1937).

Machine for grinding and polishing rims of ceramic containers such as beakers and cups. PORZELLANFABRIK KAHLA. Ger. 657,911, March 3, 1938 (Sept. 12, 1931); XII/67*a*. 17. Technical details are given of a machine for grinding and polishing rims of beakers and cups on work tables provided with holders for the work pieces. D.A.B.

Machine for sizing, truing, and polishing bars and tubes. WALTER SIEGERIST. U. S. 2,132,976, Oct. 11, 1938 (Oct. 21, 1935).

Making abrasive articles. W. D. ROSSOW (Sterling Grinding Wheel Co.). U. S. 2,136,022, Nov. 8, 1938 (Feb. 10, 1937). The method of making an abrasive article having an aperture therein comprises placing a suitable weakly bonded core in a mold along with the mix from which the article is made, compressing the material and thereby crushing the core, and subsequently curing the compressed material.

Making abrasive belts. J. H. BAKER (Behr-Manning Corp.). U. S. 2,130,753, Sept. 20, 1938 (Oct. 29, 1937).

Making a composite abrasive wheel. NORTON GRINDING WHEEL CO., LTD. Brit. 493,186, Oct. 19, 1938 (Jan. 12, 1937).

Manufacture of abrasive articles. W. J. TENNANT (Carborundum Co.). Brit. 491,654, Sept. 21, 1938 (March 6, 1937).

Manufacture of abrasive articles. CARBORUNDUM CO. Brit. 493,071, Oct. 12, 1938 (Aug. 12, 1936).

Manufacture of abrasive-coated articles. W. J. TENNANT (Carborundum Co.). Brit. 492,319, Sept. 28, 1938 (March 19, 1937).

Manufacturing coated abrasive articles. H. C. MARTIN, F. A. UPPER, AND J. B. AUST (Carborundum Co.). U. S. 2,129,954, Sept. 13, 1938 (Dec. 28, 1935).

Means for dressing grinding wheels used for form grinding. H. H. HARLEY AND JAMES YORSTON. U. S. 2,134,607, Oct. 25, 1938 (Aug. 5, 1936).

Means for polishing space bands. A. A. ROCK (Monica Rock). U. S. 2,131,639, Sept. 27, 1938 (Aug. 19, 1936).

Means for shaping the operative surfaces of grinding wheels. ARTHUR SCRIVENER. U. S. 2,135,202, Nov. 1, 1938 (Jan. 15, 1937).

Means for use in grinding and machining the seatings of valves. J. T. RATCLIFFE. Brit. 490,842, Sept. 7, 1938 (March 6, 1937).

Method and apparatus for making glass wool. GAMES SLAYTER (Owens-Illinois Glass Co.). U. S. 2,133,235, Oct. 11, 1938 (Nov. 11, 1933; renewed Jan. 9, 1937).

Method and means for grinding tapered rolls. THOMAS ZIMMERMAN (Bower Roller Bearing Co.). U. S. 2,132,280, Oct. 4, 1938 (July 3, 1933).

Milling, surface grinding, and like machine tools. J. E. REINECKER A.-G. AND M. SAUPE. Brit. 493,182, Oct. 19, 1938 (Dec. 21, 1937).

Noncurling coated abrasive product and method of making. N. E. OGLESBY (Behr-Manning Corp.). U. S. 2,136,150, Nov. 8, 1938 (Nov. 17, 1934; renewed Oct. 12, 1937).

Oscillating grinders. VAN NORMAN MACHINE TOOL CO. Brit. 491,470, Sept. 14, 1938 (Aug. 12, 1936).

Pneumatic polishing wheel. CLOTAIRE MARY. U. S. 2,131,449, Sept. 27, 1938 (May 20, 1937).

Preformed abrasive article and process of making. E. S. MERRIAM. U. S. 20,868, Sept. 27, 1938 (July 28, 1938); reissue of original 2,050,112 (*Ceram. Abs.*, **15** [10] 292 (1936)).

Producing abrasive articles. I. G. FARBENIND., A.-G. Ger. 662,636, June 23, 1938 (Feb. 19, 1932); IV*c*/39*b*. 4.02. A mixture of polymerized vinyl compounds, resins capable of being hardened, and particles of abrasives is hardened by heat application. D.A.B.

Producing carbides. H. P. KIRCHNER AND R. C. BENNER (Carborundum Co.). U. S. 2,136,107, Nov. 8, 1938 (March 23, 1935). The method of making boron carbide comprises forming a relatively large mix of boric oxide and carbon, heating the mix from the top downward by means of a heat source so located and arranged above the top surface of the mix and at such a distance therefrom that the temperature of the surface of the mix is approximately 2400°C and that the heat is distributed over the top surface of the mix while the mix is in a pasty condition and gas is escaping through it, whereby the gas is liberated first from the top portion of the mix and the mix gradually recedes without substantial bloating, and continuing the heating process until a substantial portion of the mix is converted to boron carbide.

Producing grindstones. KÜBLER & NIETHAMMER. Ger. 662,638, June 23, 1938 (June 14, 1934); IV*c*/39*b*. 22. A mass consisting of abrasive particles and a binding agent hardening at ordinary temperatures is tamped into molds. The binding agent consists of resins which are still in the liquid state, *e.g.*, condensation products of phenol and formaldehyde or urea and formaldehyde and hardening agents which react at ordinary temperatures such as agents which split off acids. D.A.B.

Production of abrasive materials. N. P. ROBIE (Carborundum Co.). U. S. 2,130,194, Sept. 13, 1938 (July 28, 1936).

Production tap grinder. A. M. DRAKE AND N. J. CROWEY (Niles-Bement-Pond Co.). U. S. 2,131,939, Oct. 4, 1938 (Aug. 1, 1936).

Roll polisher for rolling mills. SAMUEL WILLIAMS. U. S. 2,130,709, Sept. 20, 1938 (Aug. 21, 1935).

Screw thread grinding machine. S. A. HORSTMANN AND HORSTMAN, LTD. Brit. 492,592, Oct. 5, 1938 (Feb. 22, 1937).

Sharpening or grinding device. W. A. WEED. U. S. 2,131,530, Sept. 27, 1938 (Aug. 14, 1937).

Sharpening jig. R. L. KEITH. U. S. 2,131,626, Sept. 27, 1938 (Aug. 6, 1937).

Surface grinding machine. K. JUNG (trading as K. Jung Maschinenfabrik). Brit. 492,625, Oct. 5, 1938 (Feb. 26, 1937).

Tool-grinding apparatus. A. H. STEVENS (Sundstrand Machine Tool Co.). Brit. 491,780, Sept. 21, 1938 (Feb. 4, 1937).

Track rail grinding machine. WALTER HOBSON AND H. H. WOODROW. U. S. 2,132,470, Oct. 11, 1938 (Oct. 3, 1936).

Truing-tool attachment for grinding wheels. R. E. HOLBROOK. Brit. 492,549, Oct. 6, 1938 (June 26, 1937).

Valve refacing device. G. R. GAGNE AND LON SPRAKER (Snap-On Tools, Inc.). U. S. 2,136,188, Nov. 8, 1938 (May 4, 1936).

Valve seat grinding tool. J. E. GALLIVAN (Automotive Maintenance Machinery Co.). U. S. 2,133,612, Oct. 18, 1938 (Dec. 31, 1934).

Wheel-feeding mechanism. W. H. WOOD (Norton Co.). U. S. 2,133,006, Oct. 11, 1938 (Nov. 6, 1936).

Art and Archeology

Anonymous gift for the Far Eastern Department. ALAN PRIEST. *Bull. Metropolitan Mus. Art*, **33** [8] 176–77 (1938).—A pottery figure of a seated lohan has been given to the Museum. It was perhaps intended to represent Ta Mo, the founder of the Zen sect, and has been dated early Ming (1368 to 1644) but may possibly be as early as late Sung (960 to 1280). A head of Kuan Yin in white porcelain of the Tz'u-chou type is unusual in size and beautifully executed. This dates from the Yüan dynasty (1280 to 1368). A Ming ewer of the same type is of buff-colored stoneware covered with turquoise blue glaze. It is decorated in black, and the inside of the neck is aubergine. Among other pieces are an amphora-shaped funerary vase from the T'ang dynasty (618 to 906), a pottery alms box of the Han dynasty (206 B.C. to A.D. 220), a coiled monster with wings characteristic of the tomb pottery of the Wei dynasty (386 to 557), and two handsome columns of the type used to mark the lesser Han graves, the first owned by the Museum. The columns are of soft terra cotta, having been sun baked. See "Seated—," *Ceram. Abs.*, **17** [8] 270 (1938). A.A.A.

"Antique" glass. ANON. *Sprechsaal*, **71** [18] 220–22 (1938).—"Antique" glass and its production, appearance, and identification are described. Illustrated. M.V.C.

Bohemian glasses and jewels. MARG. D. TOUSSAINT. *Clarté*, **11** [5] 15–18 (1938).—A historical sketch on artistic glasses is given. R.W.D.

Ceramic color: Naples yellow. C. MORE. *Argile*, No. 185, p. 15 (1938).—Naples yellow can not be used for coloring at temperatures above 900 to 1040°C. In some cases the addition of alumina and zinc oxide and a little iron oxide will increase resistance to 1180°, thus widening the field of application of this color for underglaze coloring. M.V.C.

Chien Yao bowl with incrustation. HELEN COMSTOCK. *Connoisseur*, **102** [445] 150 (1938).—Dredged from the Min River near Foochow, this specimen of Chien Yao ware, incrusted with shells as a result of long submersion, is a tea bowl with a black glaze mottled in brown of the type described as "hare's fur" or "partridge breast." It was found in the Fukien province not far from the district where, in the Sung period, this porcellanous ware was made. M.E.P.

Closing the gap at Tepe Gawra. E. A. SPEISER. *Asia*, **38**, 536–43 (1938).—Tepe Gawra furnishes a continuous record of 3500 years, with the latest settlement abandoned 3500 years ago. S. reviews the findings in the first 16 layers. Work this year started on level 16. The Obeid age continued from levels 19 to 12. Characteristic pottery includes a deep bowl with vertically arranged decorations, globular jars with long narrow necks, boat-shaped vessels with a geometric design, and profusely decorated tortoise-shaped vessels. Comparison with nearby locations has shown that early civilizations which were contemporaneous did not have entirely uniform types of pottery, but each location had individual differences. Level 20 shows a Halaf settlement, characterized by pendants with a swastika. A sounding made previously showed five Halaf layers and one neolithic layer, or a total of 26 layers representing as many stages in the progress of man. See *Ceram. Abs.*, **17** [1] 4 (1938). W.D.F.

Early American blown glass. MARSHALL DAVIDSON. *Bull. Metropolitan Mus. Art*, **33** [9] 205–206 (1938).—Seven fine pieces of early American glass have been added to the collections on exhibition in the American Wing. Three amber-colored flasks show the use of pattern molds such as were used in Zanesville, Ohio, in the first half of the 19th Century. There is a small emerald green scent bottle also made at that period. A pitcher of clear lead glass blown in a three-part full-sized mold was probably adapted from a decanter mold. Geometric elements form a design rarely found on pitchers. Two other smaller pitchers are of the same clear lead glass. See *Ceram. Abs.*, **17** [9] 296 (1938). A.A.A.

Early English pottery. *Coronet*, **4** [5] 143–46 (1938).—Four full-page color illustrations of 17th Century pottery include a Staffordshire posset cup with a legend embossed on the rim; another posset cup with embossed Prince of Wales' feathers, one of whose four handles is fitted with a spout; a Wrotham tyg, 6 in. high, dated 1627; and a Staffordshire jug and cover in the form of an owl, $8^1/_2$ in. high, an interesting example of slipware. These pieces are in the British Museum. M.E.P.

Early English pottery figures at the Harrogate Art Gallery. H. GRANVILLE FELL. *Connoisseur*, **102** [445] 154–55 (1938).—The collection of Sir Harold Mackintosh, restricted to only the finest examples of the classical period of Staffordshire ware (1720 to 1790) including products of Astbury, Whieldon, and Ralph Woods, is composed of molded figures which are definite historico-social records of the manners and customs of the past. M.E.P.

Egyptian pottery and clay seals. WALTER B. EMERY. *Illus. London News*, **102** [2651] 247–51 (1938).—The discovery of the tomb of Pharaoh Aha at Sakkara reveals a number of ancient pieces of pottery and wine vessels sealed with clay which date from 3400 B.C. Illustrated. See "Mysterious—," *Ceram. Abs.*, **16** [8] 232 (1937). L.F.M.

English delftware. C. LOUISE AVERY. *Bull. Metropolitan Mus. Art*, **33** [7] 165–67 (1938).—Thirteen pieces of 17th and 18th Century English delftware have recently been given to the Museum. The earliest pieces in the group are Lambeth delft and include a decorative shoe (dated 1697), two pieces of white Lambeth pottery with a pinkish cast, and a bowl with a bust portrait which is identified by the initials K. W. as King William. There are several fine examples of Bristol delft, somewhat less rare than the Lambeth pottery. A.A.A.

Exhibition of Orrefors glass. HELEN COMSTOCK. *Connoisseur*, **102** [445] 148 (1938).—The influence of Edvard Hald and Simon Gaté in this Swedish factory is represented by an exhibition at the Georg Jensen galleries; it started in 1913 when the late Consul Johan Ekman acquired the factory and provided an opportunity for artists to recreate an almost dying art of engraving on glass. There are about 300 workers at Orrefors. The factory is situated in forrest land from which the wood, the only fuel used in the manufacture, is cut. The crystal glass is a potash high lead content glass. The whole process is carried out by hand, including the blowing and the decorating. The ornamented Orrefors glass is of two types; (1) engraved, done with a rotating copper disk fed with oil and emery while pressed against the glass; and (2) cut, handled with heavier disks of iron or steel. See *Ceram. Abs.*, **16** [3] 81 (1937). M.E.P.

Faience of Cafaggiolo. PIERRE VERLET. *Céram., Verrerie, Email.*, **6** [4] 131–34 (1938).—Some of the most beautiful faience ware made in Italy at the beginning of the 16th Century came from a small workshop in Cafaggiolo, Tuscany, a home of the Medici, and consisted of

paintings of people, usually on a blue ground. Italian and foreign engravings were copied. The decoration found most often is a ribbon encircling a coat of arms. The enamel background is always white. Pieces owned by the Victoria and Albert Museum are described, one of which supposedly depicts Jacopo, a famous member of the family of ceramists of Cafaggiolo, decorating the fillet bordering of a plate while a young couple looks on; beside the painter on a stool are 6 dishes containing his colors which include black, yellow, dark blue, ocher, maroon red, and green. The principal characteristics of this ware are given. Illustrated. M.V.C.

Faience industry in Hainaut. E. COLIN. *Verre & Silicates Ind.*, **9** [6] 61–64 (1938).—The ceramic industry in Belgium today is reviewed. The manufacture of faience originated in the Orient with the Egyptians and Persians. The latter perfected the ware by the 7th Century and their knowledge was appropriated by their conquerors, the Arabs, who introduced it into Europe by way of Spain which they later occupied. By the 11th Century, faience began to be known throughout Europe but attained perfection only during the Renaissance. Until the 18th and 19th Centuries when a fine faience was made in Belgium, only a coarse heavy faience covered with a stanniferous enamel existed. In 1841 the first imitation Wedgwood was made in Belgium. As the quality of a ceramic product is a function of the firing temperature and properties improve with the increase in the firing temperature, porcelain ranks first with a firing temperature of 1500° to 1550°. Its characteristics are impermeability, hardness, sonority, and especially translucidity, and it is composed of kaolin and lean feldspar. The Chinese and Japanese first made hard porcelain in 50 B.C., and Dutch and Portuguese traders introduced it into Europe in the 16th Century. Stoneware ranks second with a firing temperature of 1250° to 1350°, and faience with a white or colored paste ranks third with a temperature of 1300°. Ordinary pottery made from the commonest clays is fired to 1000°. Refractory products can not be included in this classification because of their special technical properties. M.V.C.

***Famille Noire* vase.** *Connoisseur*, **102** [444] 85 (1938).—Full-page color illustration of a square vase, tapering slightly downward; the sides are decorated with rocks, lotus plants, chrysanthemums, peonies, and pomgranate flowers, and on the neck are flowering branches. The vase has Apocryphal marks of the Ch'êng Hua period but is of K'ang Hsi date. It is 19¼ in. in height and is in the Lady Lever Art Gallery. M.E.P.

Florentine jar. P. S. H. *Bull. Metropolitan Mus. Art*, **33** [7] 169–70 (1938).—A Florentine majolica jar (early 15th Century) has been added to the Museum's collection. The jar has two handles; a yellow lion's mask and two green clusters of grapes in raised relief are set on each side. The glaze is a grayish white opaque enamel, the outline being drawn in manganese purple. This jar has been known of and followed through several collections by students of Italian ceramics. A.A.A.

Glass sellers' bills at Woburn Abbey. W. A. THORPE. *Jour. Soc. Glass Tech.*, **22** [91] 165–205 (1938).—T. records 30 receipted bills for chinaware, stoneware, earthenware, and glassware of several kinds sold by members of the Worshipful Company of Glass Sellers and others to William Russell, 5th Earl of Bedford, for use at Woburn Abbey, Bedfordshire, and Bedford House, Strand, between 1651 and 1692. G.R.S.

Heraldic stained glass at Gray's Inn: IV. F. SYDNEY EDEN. *Connoisseur*, **102** [443] 21–26 (1938).—E. describes the motifs and mediums used on 55 of the panels in this collection of enamel-painted heraldic glass of the 17th Century. Illustrated. See "Medieval—," *Ceram. Abs.*, **17** [11] 347 (1938). M.E.P.

Index of American design. ANON. *Design*, **40** [2] 3–6 (1938).—This Federal Art Project of the Works Progress Administration employing artists to rediscover America and to compile the examples of epic and folk arts from colonial times through 1890 in a series of portfolios includes the field of ceramics. The artists indexing this field have concentrated on decorative pottery of the 18th and 19th Centuries and early glass in the range from Stiegel to the brown and green flasks stamped with busts of Jenny Lind and Lafayette. Reproductions of the ware of Wister, Amelung, and Sandwich glass are also included in this portfolio. In Florida they discovered old potteries utilizing native clays. M.E.P.

Italian gold-luster formula from the 14th Century. W. GANZENMÜLLER. *Angew. Chem.*, **51**, 254–56 (1938).—G. gives a comparison of Spanish-Moorish and Italian formulas as well as a reference to a Persian formula and the Persian practice for obtaining gold-luster glaze. Glazed earthenware with gold luster was made in Italy as early as the end of the 14th Century. The process is derived from the technique used in Persia and in the Moorish part of Spain. E.W.S.

Manufacture of porcelain near Tehwa, South China. WILLARD J. SUTTON. *Bull. Amer. Ceram. Soc.*, **17** [11] 450–55 (1938).

Mosaics of Apamea. J. HELBIG. *Clarté*, **11** [6] 7–9 (1938).—Archeologists have revealed the artistic character of Syrian architecture. The main avenue of Apamea was bounded by monumental porticoes, the pavements of which were made of sumptuous mosaics picturing highly varied scenery. Inside floors were often decorated with mosaic compositions; the floor of a triclinos (dining room), dating from A.D. 539, is a large pavement 44 ft. x 28 ft. showing lifelike pictures. White and colored stones of two sizes were used for the assemblage, small cubes for human faces and larger cubes (about ⅜ in.) for the decorative motives. R.W.D.

Octagonal salt-glaze teapot and cover of Staffordshire ware. *Connoisseur*, **102** [443] 43 (1938).—Full-page color illustration of a teapot, molded with military subjects in yellow, rose, green, and blue. It has a manganese spout and handle, purple section divisions and base, and dates around 1760–70. This teapot was recently in the Elliot collection and is now in possession of Frank Partridge & Sons, Ltd. M.E.P.

Old English blue vase by Ravenscroft. ANON. *Connoisseur*, **102** [444] 78 (1938).—This vase of lead metal glass, blue in color, is believed to be the earliest piece of English glass extant made for a purely decorative purpose and is the only example in this particular color. Its date is probably 1674. The presence of lead in the metal, the "crizzling," and the absence of a seal mark place it as one of Ravenscroft's earlier pieces. Until recently it was thought to be Venetian; it is 8 inches high, and the body is "nipt diamond waies" all over. Illustrated. M.E.P.

Old Hungarian majolica. SHEILA IRVING REIN. *Connoisseur*, **102** [445] 131–35 (1938).—When expensive foreign porcelains became fashionable, characteristic designs began to be reproduced in Hungary on the Italian type of majolica with pleasingly original results; the colors are not so vivid, the background is usually white, and there is less blue and yellow. As distinct from mere peasant pottery, it became fashionable in Central Europe at the beginning of the 18th Century. Real porcelain colors were difficult to imitate in enamel; thus they were applied thickly and often resembled overglaze painting. In 1743, Francis of Alsace-Lorraine founded at Holics the oldest and most famous of the Hungarian factories in a Haban settlement. The Holics mark was an H of which there were several forms. At Holics, majolica was made exclusively until 1786 when foreign ceramic ware (English "stoneware" of the Wedgwood type) became fashionable, and Joseph II ordered that it too be made in Holics. Holics became extinct by 1827 owing to the competition of Czech and other cheap foreign porcelains. Tata, founded in 1757, is the only other genuine factory as old as Holics and had its best period under the direction of Joseph Schloegel from 1780 to 1810. Under French influence here, the shapes were Louis XVI style, but the decorations resembled those of Holics. These shapes include realistic vine-leaf plates, vegetable dishes in forms of the vegetables they were to contain, soup tureens

imitating the head of a cabbage, and miniature pieces of dainty doll-like furniture in majolica. Tata pieces were marked with a scratched T and later with a thick painted underglaze T, generally blue. Illustrated. M.E.P.

Procedure for preparing films of copper adhering particularly to glass and porcelain. WALTER WAGNER. *Oesterr. Chem.-Ztg.*, **40**, 425–26 (1937); *Chem. Abs.*, **32**, 1061 (1938).—The mirrors that are occasionally formed when CuO is reduced with H_2 are due to the presence of CuH, which is volatile and unstable at elevated temperatures. The mode of preparation of CuO and the kind of glass determine whether a mirror is formed. CuO prepared from $Cu(OH)_2$ or from $Cu(CO_3H)_2$ but not from other sources gives mirrors that are particularly good on Schott's Fiolax glass. More effective and consistent results are secured by heating CuH prepared by a modification of the method of Vorländer and Meyer. A solution of 75 g. of $CuSO_4 \cdot 5H_2O$ in 300 cc. of H_2O is reduced with $H_4P_2O_4$ prepared from 100 g. $Na_4P_2O_4$ and 310 g. H_2SO_4, density 1.130. The combined solutions are warmed at 40° to 50° until a test filtrate remains clear when heated with H_2SO_4. After filtering and washing with H_2O at 40° to 50°, the red-brown powder is preserved in a moist state. CuH must not be dried *in vacuo* and exposed to air, as it then detonates. The moist material can be painted over the surface to be plated, which is next heated to 250° to 300° in a stream of H_2 or illuminating gas. By repeating the process several times, a layer of Cu thick enough to be polished can readily be obtained.

Railway history in pottery: II. JOHN PHILLIMORE. *Connoisseur*, **102** [443] 17–20 (1938).—P. discusses prints on pottery giving examples in which the trains are drawn by 6-wheeled or 2-2-2-wheeled engines. The scenery, hills, trees, and a church with a spire, is very similar to that on the transfers in earlier ware. The engine name Express is most common on pint and $^1/_2$ pint mugs; the locomotive on bowls is called Mail. There is a large variety of color of transfers in mauve and sepia tints. At this time coffee machines made like locomotives were in vogue; one had a silver chased frame, wheels, and spirit lamp holder, and the whole "boiler and coal bunker" is of French china with hand-painted leaf and flower decoration. Country life of 1830 is depicted in the background and station scenes. Illustrated. See *Ceram. Abs.*, **17** [8] 269 (1938). M.E.P.

Red uranium glazes. ANON. *Keram. Rundschau*, **46** [20] 221–23 (1938).—Recipes of fritted and raw glazes are given. In some cases, cheaper chromium glazes may be substituted. The process of application is given in detail. The quality of the oxide is important. F.E.V.

Screen process and decoration. E. R. BRAUNER. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 112–16.—B. presents a short résumé of the history and growth of the screen process of decoration and describes in detail the various improved methods. Among the advantages of the screen process are its flexibility, fast production, and low operating cost, its cleaner and more distinct lines, and the small amounts of materials held in storage. F.J.Z.

Sophie Roubiliac in Chelsea porcelain. BELLAMY GARDNER. *Connoisseur*, **102** [444] 58–61 (1938).—The article is illustrated with a full-page color reproduction of the Chelsea model of a smiling little girl, said to be a portrait of Sophie Roubiliac by François Roubiliac. It is 8 in. high and was recently discovered by C. T. Fowler in Chelsea. It is likely that Nicholas Sprimont, godfather to Sophie, commissioned her father to make him a portrait of her for production by his Chelsea Porcelain Factory. M.E.P.

Syrian face vase of 1500 B.C. M. E. L. MALLOWAN. *Illus. London News*, **102** [2647] 92–95 (1938).—Yellow clay was used by ancient Syrians in fashioning a vase ornamented by a humorous human face. Black paint accentuated the features. Illustrated. L.F.M.

Terra cotta antefix. G. M. A. RICHTER. *Bull. Metropolitan Mus. Art*, **32** [6] 151–52 (1937).—A handsome archaic antefix has been added to the Museum's collection. It is one of the finest in existence and is in the shape of a female head. It served as the end cover tile along the side of the roof of a temple and was originally one of a row of such heads, gaily colored. The material is red terra cotta engobed with reddish slip on which a white slip was applied to the face, hair, and scroll ornament. This was wiped off cheeks and lips to allow red to show through. It was made in a mold, late archaic style, about 500 B.C. and is about the same period as the Museum's collection of Etruscan terra cotta warriors (*Ceram. Abs.*, **17** [1] 4 (1938)). It shows the Greek influence in Italy in the late archaic period. A.A.A.

BOOKS AND SEPARATE PUBLICATIONS

Art in Modern Life (L'Art dans le Vie Moderne). P. DOCKERMAN. Librarie Ernest Flammarion, Paris. 133 pp., 300 illustrations. Reviewed in *Pottery & Glass Record*, **20** [8] 203–10 (1938). A.B.S.

Decoration for the Small Home. DEREK PATMORE. Putman & Co., Ltd., London. 208 pp., 65 illustrations. Price 10s 6d net. Reviewed in *Pottery & Glass Record*, **20** [8] 203–10 (1938). A.B.S.

Decorative Art, 1938. Edited by C. G. HOLMES. Studio, Ltd., London. 144 pp., 400 illustrations, 8 color plates. Price paper 7s 6d, cloth 10s 6d net. Reviewed in *Pottery & Glass Record*, **20** [8] 205–10 (1938). A.B.S.

Early English Figure Pottery. HAROLD MACKINTOSH. Chapman & Hall, London. Reviewed in *Pottery & Glass Record*, **20** [8] 203 (1938). A.B.S.

They Wrote on Clay. EDWARD CHIERA. G. G. Cameron, editor. University of Chicago Press. 235 pp. Price $3.00. Reviewed in *N. Y. Times Book Review*, Oct. 2, 1938.—C. describes the treasures recently found in the royal tombs of Ur but principally tells of what has been learned from the clay tablets unearthed there. Four thousand years ago the Assyrians and Babylonians recorded all religious, civil, legal, commercial, and historical occurrences and transactions on unique and practically indestructible clay tablets. A stylus was used for writing, and the cuneiform characters have been deciphered. The discovery of these tablets has thrown great light on the customs of the time, which bear a striking resemblance to modern practices. M.V.C.

NEW JOURNAL

Ceramics in Art and Industry. Vol. 1, No. 1, 1938. Published by Doulton & Co., Ltd., London. The purpose of this journal is to emphasize the importance of design and craftsmanship in all pottery products. The first issue contains articles on claycraft, decorative ware and tableware, art stoneware, terra cotta, pottery sculpture, bathrooms, pipes, stoneware and chemical progress, ceramics in the service of electricity, and laboratory porcelain. The journal is well illustrated. A.B.S.

PATENTS

Decoration of glass and ceramic sheets, tile, etc. F. D. PARKINSON. Brit. 491,562, Sept. 14, 1938 (March 2, 1937).

Designs for:

Beer bottle. C. R. DEIBLE (Knox Glass Associates, Inc.). U. S. 111,959, Nov. 1, 1938 (Sept. 13, 1938).

Bottle. R. H. DALLAS (Union Oil Co. of Calif.). U. S. 111,957, Nov. 1, 1938 (Aug. 16, 1938).

Bottle. ROYDEN A. BLUNT. Can. 12,088 to 12,098, Sept. 9, 1938, and 12,103 to 12,108, Sept. 17, 1938. MISSION DRY CORP. Can. 12,099, Sept. 9, 1938. TRAIN & MCINTYRE, LTD. Can. 12,117, Sept. 24, 1938. G.M.H.

Bowl. A. J. BENNETT. U. S. 111,948, Nov. 1, 1938 (Aug. 26, 1938).

Candle holder. R. R. KOSTELLOW (United States Glass Co.). U. S. 111,634, Oct. 4, 1938 (Feb. 5, 1938).

Casserole. W. K. TITZE (Universal Potteries, Inc.). U. S. 111,314, Sept. 13, 1938 (July 1, 1938).

Combined pitcher and cover. W. K. TITZE (Universal

Potteries, Inc.). U. S. 111,339, Sept. 20, 1938 (July 1, 1938).

Condiment container. W. K. TITZE (Universal Potteries, Inc.). U. S. 111,312 and 111,313, Sept. 13, 1938 (July 1, 1938).

Condiment shaker. E. W. FUERST (Owens-Illinois Glass Co.). U. S. 112,062, Nov. 8, 1938 (Dec. 3, 1937).

Drinking glass. J. E. SPENCE (Hazel-Atlas Glass Co.). U. S. 111,229, Sept. 13, 1938 (May 16, 1938).

Glass bottle. A. C. MEYER (Glenshaw Glass Co.). U. S. 111,212, Sept. 13, 1938 (June 17, 1938). SIDNEY BRANDEIS (Continental Glass Corp.). U. S. 112,103, Nov. 8, 1938 (Sept. 9, 1938).

Glass stopper. E. F. KELM (Corning Glass Works). U. S. 111,453, Sept. 20, 1938 (July 21, 1938).

Goblet. A. J. BENNETT. U. S. 111,949, Nov. 1, 1938 (Aug. 26, 1938).

Milk bottle. W. C. TEUNISZ. U. S. 111,311, Sept. 13, 1938 (April 8, 1938).

Oyster server plate. A. J. BENNETT. U. S. 111,504, Sept. 27, 1938 (July 25, 1938).

Pitcher. W. K. TITZE (Universal Potteries, Inc.). U. S. 111,231, Sept. 13, 1938 (July 1, 1938).

Plate. ADOLPH STERN. U. S. 111,819, Oct. 18, 1938 (July 19, 1938). A. J. BENNETT. U. S. 111,950, Nov. 1, 1938 (Aug. 26, 1938).

Platter. G. J. HIGGINSON (Johnson Bros. (Hanley), Ltd.). U. S. 111,255, Sept. 13, 1938 (May 5, 1938).

Relish dish. A. J. BENNETT. U. S. 111,951, Nov. 1, 1938 (Aug. 26, 1938).

Tile. EUGENE PARKER. U. S. 112,044, Nov. 8, 1938 (Aug. 24, 1938).

Toilet article case. G. R. GRAPP (Henkel-Clauss Co.). U. S. 111,536 to 111,539, Sept. 27, 1938 (June 16, 1938).

Tumbler. E. W. FUERST (Libbey Glass Co.). U. S. 111,321, Sept. 20, 1938 (July 10, 1937). M. O. HANSEN (Libbey Glass Co.). U. S. 111,766, Oct. 18, 1938 (June 17, 1938).

Water jug. R. R. KOSTELLOW (United States Glass Co.). U. S. 112,043, Nov. 8, 1938 (Feb. 5, 1938).

Glassmelting tank wall structure and block. H. A. WADMAN (Hartford-Empire Co.). U. S. 2,136,346, Nov. 8, 1938 (June 12, 1937). A glassmelting tank wall comprises closely juxtaposed refractory blocks having hexagonal faces at the glass-contacting or exposed surface of the wall.

Producing ceramic coloring material. HARSHAW CHEMICAL CO. Ger. 661,835, June 2, 1938 (June 8, 1933); VI/80*b*. 23.03. An antimony compound is heated with oxygen. Mixtures of compounds of titanium, antimony, and chromium containing oxygen are heated with a substance containing an element which is electropositive to chromium, such as sodium. D.A.B.

Cements

Four component systems CaO–Al_2O_3–$CaCl_2$–H_2O and CaO–SiO_2–$CaCl_2$–H_2O. R. NACKEN AND R. MOSEBACH. *Z. Anorg. & Allgem. Chem.*, **228**, 19–27 (1936).—The compound $3CaO{\cdot}Al_2O_3{\cdot}CaCl_2{\cdot}10H_2O$ was formed by the interaction of calcium aluminate ($3CaO{\cdot}Al_2O_3$) and a solution of $CaCl_2$ at 30°. The authors stated that it was this reaction which controlled the rate of setting of Portland cement. No compound was formed by $3CaO{\cdot}SiO_2$ and calcium chloride, although the reaction of calcium silicate and water was retarded by the presence of $CaCl_2$. E.P.

Fused cement. ANON. *Verre & Silicates Ind.*, **9** [18] 208–10 (1938).—The manufacture of fused cement differs from that of Portland cements. Bauxite and limestone are the raw materials. Open-hearth furnaces fired with coal dust burning in preheated air to 1550° to 1600° are used. The fused cement is subjected to the electric arc and cast into ingot molds. When cold, the clinker is a dark rock, compact and hard like basalt. Crushing and grinding require great energy. The milled clinker receives no addition; setting time is regulated by the rate of cooling; the methods of cooling are trade secrets and are controlled by the laboratory. The chemical composition of fused cements, which may vary within large limits, is SiO_2 + TiO_2 10 (TiO_2 2%), Al_2O_3 40, FeO + Fe_2O_3 10, and CaO 40. Rather than a loss on firing there is a gain because of the oxidation of FeO. Fused cement hardens rapidly and acquires a high resistance in 24 hr., and hydration reactions are highly exothermic. Conditions of setting are given. Specific gravity is 3.1. Good chemical resistance is due to the absence of crystallized lime hydrate and the presence of alumina in solution. Fused cement is becoming more generally used as a refractory cement. Fused cements are indicated where haste and high mechanical resistance are required, for working in the cold or in contact with aggressive liquids, or for coatings subjected to wear. For best results, fused cement must not be contaminated by lime or Portland cement and it must be mixed carefully to plastic consistency without excess water and kept moist the first few days; hydrofuges must be avoided and preliminary tests must be made if colors are used. M.V.C.

Gypsum as building material. E. F. MACTAGGART. *Cement, Lime, & Gravel*, **11**, 60–61, 86–88, 121–22, 155–56, 173–75, 186, 202–203 (1937).—A general account is given of the use of gypsum as a building material, the methods in use for calcining gypsum, and the manufacture and properties of calcium sulfate plaster and related products, particularly plaster blocks and plaster board. E.P.

Hydraulic properties of blast-furnace slag. G. MUSSGNUG. *Mitt. Forsch.-Anstalt. Gutehoffnungshütte Oberhausen A.-G.*, **6** [6] 153–68; [7] 169–80 (1938).—As the properties of the latent hydraulic blast-furnace slags are still fairly incompletely known, an exhaustive investigation was made into the reactivity and conditions under which the slag sets. New methods were used to determine the effect of chemical composition, state, and melting temperature on the properties of the highly basic latent hydraulic slags occurring in the manufacture of various types of pig Fe. The hardening of the rapidly cooled highly basic blast-furnace slag depends more on the applied melting temperature than on the chemical composition and behavior; the hotter the slag is melted, the better it hardens. Some properties are strongly influenced by the ratio SiO_2/Al_2O_3; the hydraulic strength increases with increasing SiO_2 content, while the strength in air does not increase and shrinking decreases. Although increasing the Al_2O_3 content greatly improves hardening in water and air, it also very strongly increases shrinking. M. describes a rapid testing method which permits the determination of the reactivity of highly basic slags within 12 hr. with good practical success. Tables of composition and equilibrium diagrams of slags are given. 23 references. M.H.

Kinetics of silicate formation in the system CaO–SiO_2. P. S. MAMYKIN AND S. G. ZLATKIN. *Zhur. Fiz. Khim.*, **9**, 393–406 (1937).—Three mixtures of CaO (C.P.) and SiO_2 (colorless rock crystal) in the molecular ratio 1:1 were fired at 1400°, 1200°, and 800°, and one mixture (1:25) was fired at 1200°. The reaction velocity increases with the temperature but does not increase with considerable excess of SiO_2. In the 1:1 mixture at 1400° and 800°, about equal amounts of $2CaO{\cdot}SiO_2$ and $3CaO{\cdot}2SiO_2$ are formed. In the same mixture at 1200°, mostly $2CaO{\cdot}SiO_2$ is first formed; the amounts of $2CaO{\cdot}SiO_2$ and $3CaO{\cdot}2SiO_2$ then become almost equal. In the 1:25 mixture at 1200° $3CaO{\cdot}2SiO_2$ forms in the whole interval in a greater amount. No wollastonite was found. P.B. & E.S.

Magnesia and special ceramic bodies. F. DETTMER. *Keram. Rundschau*, **46** [23] 253–56 (1938).—Alumina silicates are the more important constituents of ceramic

bodies; magnesia silicates are next. There is a continuous series of intermediates between porcelain and magnesia bodies. Magnesia reduces the expansion factor. The magnesia compounds require a skilled treatment. D. gives compositions and corresponding glazes and deals with special bodies containing TiO_2 (up to 80%), Al_2O_3 (99.8%), and sillimanite and their electrical properties. F.E.V.

Microporite. F. O. Anderegg. *Rock Products*, **39** [5] 48–51 (1936).—Microporite is a hydrated calcium silicate having unusual strength for its low weight; it is fireproof, has good heat and sound transmission characteristics, is pure white, is practically insoluble in water, has remarkable resistance to the action of corrosive salt solutions and even acids, and is suitable for prefabricated housing. Full details of its manufacture are given. E.J.V.

Mix crystal formation of tricalcium silicate and tricalcium aluminate. W. Jander and J. Wuhrer. *Zement*, **27** [25] 377–79 (1938).—Mixtures of $2CaO{\cdot}SiO_2$ + $CaCO_3$ + Al_2O_3 or $3CaO{\cdot}SiO_2$ + $3CaO{\cdot}Al_2O_3$ were fired at 1400°C and the X-ray patterns carefully measured. The solubility of aluminate in the silicate crystal is 6 to 7%. The mix crystal formation does not affect the network constants. The provisional explanation substitutes 10Al for 3Ca + 6Si. Total volumes of ions and total valencies are equal. See "X-ray—," *Ceram. Abs.*, **17** [9] 317 (1938). F.E.V.

Periodicity of binding properties of a series of compounds of the calcium aluminates and silicates type. V. A. Kind and V. F. Zhuravlev. *Tsement*, **5** [3] 24–28 (1938).—Not only calcium aluminates, silicates, and ferrites possess binding properties. According to the Mendeleev law, it can be supposed that a range of chemical compounds also has them. Experimental data available confirm this possibility. It is also known that some compounds are like calcium aluminates and silicates yet have no binding properties. It is concluded that this is intimately connected with the periodic law: some oxides of alkaline earth metals give compounds having binding properties (Ca, Sr, and Ba); others do not (Mg and Zn). P.B. & E.S.

Portland cement constitution: II. K. Koyanagi, S. Katoh, and T. Sudoh. *Zement*, **27** [24] 363–67 (1938).—A highly aluminous clinker was sieved through a 10,000-mesh sieve and fractioned in seven parts by centrifugation. The chemical analysis and the computation according to the Bogue method show that the lighter parts contain a large amount of $3CaO{\cdot}Al_2O_3$. The heavier parts have an increasing amount of $2CaO{\cdot}SiO_2$. The X-ray method agrees with these results. In the densest fraction, some $3CaO{\cdot}SiO_2$ was identified. The tricalcium aluminate in clinker is not free from $3CaO{\cdot}SiO_2$; there is a mix crystal formation and network contraction. See *Ceram. Abs.*, **17** [6] 211 (1938). F.E.V.

Preparation of aluminous cement from aluminum phosphate ore: II. Kei-ichi Akiyama. *Waseda Applied Chem. Soc. Bull.*, **15** [1] 1–7 (1938).—A. studied the large-scale experiment of preparing aluminous cement from aluminum phosphate ore. Aluminum phosphate ore is used as a source of alumina, and limestone and calcium phosphate ore are used as raw material of CaO. These materials are mixed with cokes and quartzite and heated in the electric furnace which is used for manufacturing phosphorus. A. concludes that it is not difficult to evaporate phosphorus completely and to produce cement. Y.K.

Reactions in the solid state. W. Jander. *Z. Ver. Deut. Ing.*, **80** [17] 506–10 (1936).—Reactions in the solid state are those occurring in casehardening, cement manufacture, and ceramic processes. The raw materials for cement production, $CaCO_3$ and $Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$ (kaolinite), are heated, and CO_2 and CaO are formed; H_2O, Al_2O_3, and SiO_2 separate. CaO reacts with Al_2O_3, forming $CaO{\cdot}Al_2O_3$, and the reaction with SiO_2 forms $2CaO{\cdot}SiO_2$. Besides these two, other reactions occur which form $3CaO{\cdot}Al_2O_3$ and $3CaO{\cdot}SiO_2$, and sintering and melting take place, ending the reaction. In ceramic processes, clay ($Al_2O_3{\cdot}2SiO_2{\cdot}2H_2O$) is heated and forms $Al_2O_3{\cdot}2SiO_2$ + $2H_2O$. A reaction in the solid state then takes place, the nature of which is not yet known. On further heating, mullite ($3Al_2O_3{\cdot}2SiO_2$), which is the base of many ceramic masses, is formed. The last reaction then takes place in the sintered state. The mechanism of such reactions is explained by the change of place of particles in the crystal lattice after the temperature has become high enough to cause oscillation of the particles wide enough to penetrate into adjacent crystals. This is illustrated in many examples of reactions between oxides. See *Ceram. Abs.*, **14** [4] 102 (1935); **16** [1] 45; [10] 313 (1937); **17** [3] 120 (1938). M.H.

Reactivity of silica at temperatures at which Portland cement clinker is fired. S. D. Makashev and K. K. Khazanovich. *Vsesoyuz. Nauch.-Issled. Inst. Tsementov*, No. 18, pp. 36–56 (1937).—The processes of mineral formation of $2CaO{\cdot}SiO_2$ in the system CaO–SiO_2 depend on the grain size of the silica introduced into the raw mix. M.V.C.

Relation of compositions and heats of solution of Portland cement clinker. Herbert Insley, Einar P. Flint, Edwin S. Newman, and J. Arthur Swenson. *Jour. Research Nat. Bur. Standards*, **21** [3] 355–65 (1938); R.P. 1135. Price 10¢.—The results of chemical and microscopic analysis and heat-of-solution measurements on 26 samples of commercial Portland cement clinker are reported. A comparison of compound composition by microscopic analysis and by calculation from chemical analysis shows that (1) the content of $3CaO{\cdot}SiO_2$ by microscopic analysis is greater than by calculation, except for very low Al_2O_3/Fe_2O_3 ratios; (2) the content of $2CaO{\cdot}SiO_2$ is less by microscopic analysis, except for very low Al_2O_3/Fe_2O_3 ratios; (3) microscopically determined "dark interstitial" material is less than calculated $3CaO{\cdot}Al_2O_3$ for low Al_2O_3/Fe_2O_3 ratios and greater for high Al_2O_3/Fe_2O_3 ratios; and (4) microscopically determined "light interstitial" material is greater than calculated $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$ for low Al_2O_3/Fe_2O_3 ratios and approximately equal for high ratios. In addition, qualitative and quantitative microscopic analyses indicate that the crystalline compounds are not pure but contain limited amounts of material in solid solution. Glass is present in all samples studied. A comparison of observed heats of solution with those calculated from chemical analysis and from microscopic analysis shows a fairly close correspondence, but the assumptions on which the calculations by both methods are based are inexact. R.A.H.

Rôle of geology and chemistry in the technique of the cement industry. G. V. *Argile*, No. 184, pp. 27–29 (1938).—The evolution of the cement industry in the region of Tournaisis (France) was brought about by the more exact determination of the value and use of the different limestone veins; as a result, the entire Tournaisis basin now produces cement. The Boulonnais region has undergone the same evolution. With the aid of chemistry, the manufacture of cement can be undertaken even with very pure limestones (95 to 98% calcium carbonate), but only on condition that a deposit of clay of the desired quality is discovered near at hand. This necessitates a detailed geological knowledge of the region where the industry is to be established. Chemical control of production and research are now universal. M.V.C.

Specific surface of cement and ground rock. H. Elsner von Gronow. Translated in *Cement & Lime Manuf.*, **11** [3] 55–57 (1938); see *Ceram. Abs.*, **16** [1] 32 (1937). G.R.S.

Structure of the glassy phase in Portland cement clinker. L. T. Brownmiller. *Amer. Jour. Sci.*, **35**, 241–59 (1938).—B. discusses the products obtained when molten mixtures of CaO, SiO_2, Al_2O_3, and Fe_2O_3 are cooled at different rates. When cooling was practically instantaneous a glass resulted; when it was very slow the equilibrium crystalline phases appeared. At intermediate rates there resulted a metastable phase whose composition is determined by the composition and viscosity of the liquid and by the rate of migration of the constituents. The composition of this phase varies continuously and is accompanied by a continuous variation in optical properties

On the other hand, this phase gives an X-ray pattern which is independent of composition. It is therefore believed to be made up of isomorphously replaceable units which do not conform to a simple stoichiometric formula. The X-ray lines lie in practically the same position as the intense lines of $3CaO \cdot Al_2O_3$, although no Al_2O_3 may be present in the mix. Consequently, the X-ray pattern alone is not sufficient to identify $3CaO \cdot Al_2O_3$ in mixtures such as cement clinker where the metastable phase may be present. It is likely that errors of this kind have already been made. See also "Method—," *Ceram. Abs.*, **16** [8] 234 (1937). J.B.A.

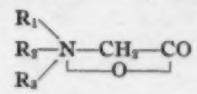
System alkali oxide–CaO–Al_2O_3–SiO_2–CO_2: VI, Equilibria in the system CaO–SiO_2–CO_2. C. KRÖGER AND K. W. ILLNER. *Z. Anorg. & Allgem. Chem.*, **229**, 197–224 (1936).—A study was made of the effect of the presence of different calcium silicates on the dissociation pressure of calcium carbonate. The dissociation pressures were not affected by Ca_2SiO_4, but $Ca_3Si_2O_7$ greatly increased the percentage dissociation. Direct reaction was found between silica and calcium carbonate, independent of any degree of dissociation of the $CaCO_3$. For Part V see *Ceram. Abs.*, **17** [2] 87 (1938). E.P.

Texas pioneer produced cement. MACGREGOR ANDERSON. *Concrete, Cement Mill Ed.*, **46**, 215 (1938).—More than a hundred years ago M. Landgraffe had rectangular pits dug on a sloping hill, parallel with the prevailing winds. Twigs, branches, and dried grass were first put in the pits, followed by limestone mixed with shells, more grass, and clay. This was then ignited. The clinker was ground in hand mortars. W.D.F.

Thermal problems in the cement industry: I–II. P. DUMESNIL. *Chaleur & Ind.*, **19** [218] 413–18 (1938).—D. briefly reviews the history and technology of the Portland cement industry and discusses its thermal problems. The thermochemical reactions involved are indefinitely known, there being little quantitative data available on the formation of the various cementation compounds. The physical state of the raw materials is important since the process does not involve complete fusion. Plant control men are attempting to lower the cost of production by better combustion technique, kiln design, and the use of waste heat from the cooling clinker for drying and preheating. Precipitation of dust from the stack gases prevents large stack losses of finished cement. An extensive bibliography is given. V.D.F.

PATENTS

Cement mass. KARL DAIMLER AND HEINZ THRON (I. G. Farbenind. A.-G.). U. S. 2,131,533, Sept. 27, 1938 (June 7, 1935). As a new composition of matter a mixture of cement and a betaine of the following formula:



wherein R_1 stands for a high molecular alkyl radical and R_2 and R_3 stand for low molecular alkyl radicals.

Colored cements and their process of manufacture. P. GERIMONT. Brit. 491,051, Sept. 7, 1938 (Feb. 10, 1937).

Modification of the method for producing blast-furnace slag cement according to Ger. 647,807. SOC. ANON. DES CIMENTS DE THIEU AND LEON BLONDIAU. Ger. 661,848, June 2, 1938 (March 13, 1935); VI/80*b*. 1.05. The blast-furnace slag is ground with a calcium sulfate which has been treated for 5 to 15 min. at 900° to 1200°C. Only calcium sulfate treated in such a manner is added to the slag; no other cement constituent is added. D.A.B.

Portland cement clinker quenching process. H. E. KAISER (California Portland Cement Co.). U. S. 2,130,625, Sept. 20, 1938 (Sept. 20, 1937).

Process of manufacturing Portland cement. H. E. KAISER (California Portland Cement Co.). U. S. 2,130,624, Sept. 20, 1938 (Sept. 20, 1937).

Process for quenching Portland cement clinker. H. E. KAISER (California Portland Cement Co.). U. S. 2,130,626, Sept. 20, 1938 (Sept. 20, 1937).

Use of Portland cement with a small amount of heat for rendering the cement hard in the construction of dams and other large construction projects. RIVERSIDE CEMENT CO. Ger. 662,981, June 30, 1938 (Jan. 25, 1932); VI/80*b*. 3.01. Portland cement, heated slightly for hastening hardening, consists of ground clinker of the composition $3CaO \cdot Al_2O_3$ less than 12% (preferably less than 8%), $2CaO \cdot Fe_2O_3$ less than 3% (preferably 0%), $3CaO \cdot SiO_2$ less than 10% (preferably less than 5%), in which the value of the function of $\%3CaO \cdot SiO_2 + 2 \times \%3CaO \cdot Al_2O_3$ is less than 45% (preferably less than 40% and best at 35%). A specific surface of at least 1300 cm.²/g. (preferably 1500 cm.²) is given to the composition by fine grinding. D.A.B.

Enamel

Abrasive cleaning practice and equipment. R. E. DONNELLY. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 131–33.—Roto blasting offers faster blast cleaning, better finish for enamel adherence, and the elimination of costly compressed air with its generally prevalent moisture troubles. Using steel abrasive, roto blasting not only eliminates siliceous dust hazards, but actually takes the operator out of the blast room entirely. F.J.Z.

Acid-resistant and acid-stable enamels. VIELHABER. *Emailwaren-Ind.*, **15** [16] 115–16 (1938).—V. discusses the differences in the meaning of the two expressions as used in the enamel industry. M.V.C.

Atomic hydrogen and enameling. F. HERKNER. *Illustr. Ztg. Blech-ind.*, **67**, 512–13, 537–38 (1938); abstracted in *Referat. Silikatliteratur*, **5** [7] 5425 (1938).—Various enamel defects such as blisters, seeds, scales, bubbles, and needle points are discussed. The majority of these defects is caused by atomic hydrogen which is usually diffused by iron. Moisture is superheated during calcining, and H_2 is separated from O which combines with the iron and forms a black coat, while hydrogen diffuses through the sheet iron. On enameling, part of the hydrogen escapes through cracks while the remainder remains occluded and produces a series of defects. M.V.C.

Black edging practice. J. E. ROSENBERG. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 129–34.—In order to get good results with black edge when applied on dry bisque, the following points should be considered: (1) apply as thin a layer of ground coat as possible; (2) dry the ground coat thoroughly before applying the black edge; (3) if possible, apply the black edge on the warm ground-coat bisque; (4) the black edge should be applied in such a manner as to be thoroughly dry when it hits the ground coat; and (5) the black edge should be milled as needed. F.J.Z.

Boric acid and borates. VIELHABER. *Emailwaren-Ind.*, **15** [14-15] 106–107 (1938).—The forms of boric acid used in enameling are $H_2B_4O_7$, HBO_2, and H_3BO_3. Alkali borates are relatively soluble in water. Borax melted with metallic oxides forms colored glasses. The less pure sheet iron for enameling is, the more boric acid should be used. M.V.C.

Cast iron structure changes during firing cycle of vitreous enamel. R. B. SCHAAL. *Steel*, **100** [23] 72, 90 (1937).—The structure of unenameled casting is illustrated, showing a matrix of lamellar pearlite with white ferrite adjacent to fine network-like graphite nests. After enameling, the pearlite is converted almost entirely into ferrite and graphite, probably weakening the casting. The following composition is given as an iron easy to cast and of good strength after enameling: silicon 2.40, manganese 0.75 to 0.85, phosphorus 0.70 to 0.75, sulfur 0.065 to 0.075, and total carbon 3.40 to 3.50. H.E.S.

Cleaning raw ware before enameling. R. ALDINGER. *Glashütte*, **68** [18] 313–16 (1938).—Methods used for

cleaning cast-iron or sheet-iron ware are analyzed. The ware is calcined at 700° to 800°C and pickled in a 10 to 15% HCl or 6 to 12% hot S solution, washed in cold or hot water, neutralized with boiling caustic soda solution, washed in a warm soda solution, and dried. This method yields the best results but is rather expensive. The other 3 methods are variations of the first; they are less expensive but also less reliable. M.V.C.

Collection, handling, and use of reclaimed enamels. GEORGE N. TUTTLE. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 137–47.—The chief advantages of the pneumatic or vacuum conveying and collecting system for reclaiming enamels are (1) improved working conditions through the elimination of dust hazards, (2) salvaging of the more valuable materials otherwise discharged into the atmosphere, (3) conservation of space through compactness of collecting station and conveying pipe lines, (4) increased opacity of reclaimed enamel by salvaging mill additions, (5) cleaner enamel as a result of finer screening and magnetic separation of dry material, (6) increased uniformity and workability of the enamel, (7) decreased wear on spray guns as a result of the increase in enamel fineness without further grinding, and (8) increased cleanliness of the entire enameling department with resulting increase in operating efficiency. F.J.Z.

Colors and color matching. J. E. EAGLE. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 68–77.—Cadmium and cadmium-selenium colors probably cause most variations in shades. The primary responsibility rests on the color manufacturer to provide oxides which will have the greatest possible firing range under commercial enameling conditions. The term "oxides" as applied to enamel colors is a misnomer, in that these so-called oxides are usually silicates, zincates, aluminates, chromates, or mixtures of these compounds. F.J.Z.

Control and consistency of enamels for dipping. W. H. WOLF. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 101–106.—The consistency of the enamels depends upon three variables, *viz.*, specific gravity, viscosity, and set. W. discusses the common methods of control of these variables as practiced in plants. F.J.Z.

Control and consistency of enamels for spraying. L. C. ATHY. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 83–89.—Raw materials should be checked against a standard, and mill-room practice in general should be as uniform as possible. Mills should be cooled when temperature exceeds 90°F, and specific gravities and viscosities of milled enamels should be checked. The Bingham plastometer, Gardner mobilometer, and Irwin's modification of the plastometer are discussed. F.J.Z.

Degreasing metal by solvent and its vapor. CHARLES W. HARDY. *Ind. Finishing*, **13**, 31–32, 37–38 (Aug., 1937); *Metals & Alloys*, **9** [4] MA236 (1938).—H. describes cleaning of metal articles by the vapor, immersion, and spray processes.

Degreasing metals. ANON. *Metal Ind.* [London], **50** [5] 168 (1937).—The degreasing of metals prior to vitreous enameling by means of noninflammable solvents is described and outlined. H.E.S.

Descaling and derusting by sandblasting. ANON. *Oberflächentech.*, **15** [18] 181–82 (1938).—Cleaning rust and scale from metal surfaces before putting on a protective coating is done most satisfactorily by sandblasting. Cleaning installations must be selected according to purpose. Sharp quartz sand of 1 to 1.5 mm. grain size under a pressure of 1 to 2 atm. is the most advantageous; the energy required amounts to 2.5 to 7 h.p. and 3 to 12 m.³ air/min., according to capacity. Examples are described. M.H.

Design and factors affecting hairlining. B. T. SWEELY. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 46–53.—Hairlines in general may be divided into two types, *i.e.*, white hairlines and black hairlines. The latter are usually the more troublesome, and corrective measures do not always present themselves immediately. S. discusses the importance of sound design and forming of ware in keeping hairlining losses low and offers some suggestions in milling, application, and firing of the ground coats, black edge, and cover coats which have been found useful in minimizing hairlines. F.J.Z.

Determination of the whiteness of enameled ware. K. P. AZAROV AND N. S. KHARCHENKOVA. *Zavodskaya Lab.*, **7**, 238–39 (1938).—The determination is made with a photoelectrical device, consisting of a testing head containing an electric lamp and a selenium photoelectric cell of an area of 10 cm.² and a galvanometer. The current is obtained from an accumulator cell over rheostats. The head of the device is put on a standard enameled plate and the galvanometer readings are regulated to obtain the reading 68.5, corresponding to a conventional reflection coefficient, *P*, of the standard plate. After this, the head is put on the samples and the whiteness (reflection coefficient) is obtained from the galvanometer reading as percentage to the standard plate. P.B. & E.S.

Difficulties encountered when enameling cast iron. VIELHABER. *Emailwaren-Ind.*, **15** [4] 24–25 (1938).—The formation of bubbles in enamel is accounted for by a development of gases, chiefly CO and O, during enameling. The melting interval of ground enamel should, in this case, be raised. M.V.C.

Discussion of "Production of castings for porcelain enameling." G. H. SPENCER-STRONG. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 133–36; see *Ceram. Abs.*, **17** [1] 10 (1938). F.J.Z.

Effect of fluorine and ammonia on the acid resistance of enamels. K. P. AZAROV AND N. KHARCHENKOVA. *Zhur. Priklad. Khim.*, **11**, 261–70 (1938).—Three series of batches (7 in each) were investigated: (1) those having a B_2O_3 content of 13.49 to 15.05%, (2) those having no B_2O_3, and (3) those having 25.99 to 27.46% B_2O_3. The effect of fluorine was less in series 1 and 2; in some cases, it increased the acid resistance. The increase in the alumina content in enamels of series 1 and 3 is admissible for HCl acid only to 0.12 mol. In series 2, alumina has no effect on the acid resistance; at high pressures and temperatures, it increases acid resistance. P.B. & E.S.

Effect of modern blast-furnace practice on the manufacture of pig iron. W. E. CURRAN. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 107–21.—C. discusses the improvement in quality of pig iron resulting from modern blast-furnace practice and traces the improvement in design and operation of the blast furnace as effected in the last 25 years. Illustrated. F.J.Z.

Electric furnaces. ANON. *Usine Belge*, No. 745, pp. 45–46 (1938); abstracted in *Verre & Silicates Ind.*, **9** [25] 295 (1938).—The advantages of using electric furnaces are given. In enameling, where the thermal treatment of ware must be carried on in pure atmosphere free from burned gas and dust, the electric furnace assures a uniform temperature of the interior and constant operation and improves the output of quality ware. The absence of a supply of fuel and a reduction in personnel are other factors. The laboratory type furnace which has very small dimensions is especially recommended for applying enamel to jewelry; the temperature is regulated automatically, and the pyrometer reading will give the exact temperature of the pieces fired. The low radiation of the furnace permits installation any place. M.V.C.

Enamel as bonding agent for ceramic materials and as pigment. VIELHABER. *Emailwaren-Ind.*, **15** [25–26] 176 (1938).—Attempts to use enamel as a bond for abrasives are briefly discussed. Corundum and fused alumina disks with an enamel bond may be manufactured. Silicon carbide is attacked by enamel and therefore can not be used. The use of enamel as pigment for paints in the U. S. is mentioned. M.V.C.

Enamel research. A. DIETZEL. *Naturwissenschaften*, **25**, 440–43 (1937); *Chem. Abs.*, **31**, 8858 (1937).—D. reviews the fundamentals of enamel technique and discusses in detail the influence of expansion coefficients and the importance of the presence of adhesive oxides (CoO or NiO).

Enamel-shop costs. WADE WILLEY. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 22–

28.—Enamel shop costs consist of three main factors, *viz.*, quality, quantity, and economy. Quality depends on the constant effort to adopt new methods of processing and testing which will better the product and on the reduction of scrap, rework, and repairs by providing corrections for defects at their first indication. Economy depends on material, labor, and the burden costs. F.J.Z.

Enamel-shop housekeeping. W. H. PFEIFFER. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 78–82.—The fair consideration of good enamel-shop housekeeping implies not only the adage "a place for everything and everything in its place" with plenty of janitors to keep the dirt moving but also a number of other factors which contribute to efficiency, safety, and success in the enameling process. P. discusses various sources of dirt which have been known to cause blisters and other defects on finished ware and points out the economy of cleanliness in inspiring the workmen to do better work. F.J.Z.

Enamel slips. Contribution to the knowledge of fish-scales. JOSEPH KLÄRDING. *Sprechsaal*, **71** [7] 93–95; [8] 106–107 (1938).—Enamel slips have a fine structure similar to clays. Slips only gradually liberate the chemically combined water, which varies between 0.8 and 1.5%, at higher temperatures. After 5 min. of slow firing at enamel temperature, not all the volatile constituents of the enamel batch are expelled. Since a high-grade enamel requires a homogeneous melt, care must be taken that the chemically combined water and the gases formed may be liberated. The grain size of the enamel slip, its chemical composition, and the selection of raw materials affect dehydration and elimination of volatile constituents and hence the formation of fishscales. M.V.C.

Factors affecting efficiency of the spraying operation. WESLEY G. MARTIN. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 82–87.—Six of the major factors which affect the efficiency of the spraying operation are enamel, man or machine, spray gun, enclosure for spraying, type of ware, and wages and incentive. The enamel should be constant in gravity, mobility, and yield point at all times. Mechanical spraying should be used wherever possible and practical, and sprayers should be capable of maintaining constant application. The importance of good spray guns and equipment is stressed, as are good lighting, facilities for dust removal, and a system of payment which will make diligent efforts on the part of the sprayer worth while. F.J.Z.

Factors affecting ground-coat dipping. L. E. NORDHOLT. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 148–51. F.J.Z.

Ferrites: I. A. E. VAN ARKEL, E. J. W. VERWEY, AND M. G. VAN BRUGGEN. *Rec. Trav. Chim.*, **55**, 331–39 (1936).—An X-ray examination of highly heated mixtures of MO + Fe_2O_3 (where M is a two-basic metal) showed that in Fe_2O_3-rich mixtures many mixtures behave similarly. The solid solutions with a greater content of Fe_2O_3, than 50 : 50 have a crystallographic structure which conforms to a subtraction phase according to Hägg. Mixtures of Fe_2O_3 with Mg, Zn, Cu, Mn, Ni, Co, Cd, Ca, and Pb were investigated. 19 references. **II.** E. J. W. VERWEY, A. E. VAN ARKEL, AND M. G. VAN BRUGGEN. *Ibid.*, pp. 340–47.—The mixability of some ferrites with metal oxides was investigated at elevated temperatures. Mn_3O_4 dissolves considerable amounts of Fe_2O_3 (at 1300°C, $Mn_3O_4 : Fe_2O_3 = 1 : 6$). The solid solutions originating at high temperatures of MgO + $MgFe_2O_4$ and NiO + $NiFe_2O_4$ slowly separate at 1000°C. The elementary cell of the ferrites is almost exactly twice that of the oxides. A new compound was found in copper ferrite with $CuO : Fe_2O_3 = 3 : 1$ but the nature of it could not be established. M.H.

Fundamentals of porcelain enamel. C. W. PARMELEE. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 21–38.—P. gives a résumé of fundamentals relating to glasses which have been disclosed chiefly during the past few years. Commercial glasses, enamels, and glazes are all glasses, and the three hypothetical states—brittle, viscous, and fluid—are characteristic of each. In regard to the structure of glass, it is considered either as a strongly associated substance containing very complex molecules or as a network of silica atoms with various bases in the interstices. P. reviews the work done by various investigators on the physical properties of glasses and their measurement, including expansion, viscosity, surface tension, Young's modulus, tensile strength, hardness, color, etc., and challenges any skeptic who fails to recognize the economic value of the fundamental research of today. F.J.Z.

Furnaces. J. E. HANSEN. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 87–93.—H. reviews the improvements in the small electric, gas, and oil continuous furnaces. The one radical development of major importance is the fairly recent application of radiant tubes in enameling furnaces, both continuous and box-type units. F.J.Z.

Gas serves gas. GAS INDUSTRY HOUSE. *Metal Ind.* [London], **51** [9] 7 (1937).—An up-to-date gas-fired enameling furnace is described and illustrated, and the advantages of town gas as a fuel are pointed out. H.E.S.

High-capacity pusher furnaces. A. SPRENGER. *Z. Ver. Deut. Ing.*, **81** [12] 357–59 (1937).—S. describes installations in which the capacity of a pusher furnace was greatly increased by water-cooled skids arranged some distance from the bottom of the furnace; in some cases, the capacity was three times that of former furnaces. The water consumption of a 15 to 20 m. long furnace was 8 to 10 $m.^3$/hr./skid, and the heat consumption was 240,000 to 400,000 Cal./hr., corresponding to a temperature rise of the cooling water from 20° to 50° to 60°C. M.H.

Improved core-making practice. V. STOBIE. *Metal Ind.* [London], **50** [15] 437–38 (1937).—S. describes a new method of core making, in which a continuous stream of sand flows at high speed from a nozzle at the end of a flexible delivery pipe. In addition to quicker production, a better finished core is obtained. H.E.S.

Influence of iron oxide on resistivity of enamels. F. H. SCHULZ. *Keram. Rundschau*, **46** [23] 257–58 (1938).—Tests show that mill additions of iron oxide cause enamels of poor resistivity to deteriorate. To use iron as a coloring agent, good enamels are needed. The amount of iron oxide solved during firing must be deducted from the mill addition. F.E.V.

Institute and the enameler. EMERY L. LASIER. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 58–69.—L. discusses the five major fields of Institute work, *viz.*, research, sales promotion, service, public relations, and membership. As now constituted, the Institute membership is divided into four active divisions, *viz.*, jobbing shop, signs, table top, and frit. The Porcelain Enamel Institute is a collection of units of activity, any one or two of which, alone, would fail to satisfy the requirements of the enamel industry, but which, acting together, through all of the various and diversified lines of coöperative endeavor, serve and advance the interests of the industry and the members of the enamel industry. F.J.Z.

Milling practice. E. C. AYDELOTT. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 69–78.—A. reviews a few of the well-established principles of good mill-room practice. Some of the improvements in mill-room practice, together with a number of common troublesome problems and their solutions, are brought out. F.J.Z.

Molding sand and facing materials. R. B. SCHAAL. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 121–31.—Probably the first consideration in selecting a sand for any given type of work is suitability of grain size. Refractoriness, permeability, and green strength are also important. Gating and pouring are intimately related. F.J.Z.

Mottling grayware enamel. E. C. DEXHEIMER. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 148–54.—Mottling is very greatly influenced by every variable encountered in an enameling shop. It is a chemical reaction and takes place best under certain definite conditions. F.J.Z.

Opacification by zirconium and cerium oxides. W.

SCHULTZ. *Keram. Rundschau*, **46** [25] 277–79 (1938).—Different processes of manufacture of zirconium oxide give products of similar chemical composition but of distinct opacifying properties. The hydroxide gel, properly fired, is a powerful opacifier. The tetravalent cerium oxide gives stable trivalent oxide and oxygen which acts as secondary opacifier. An excess of gas must be avoided. F.E.V.

Physical testing of porcelain enameled hollow ware. G. H. MCINTYRE. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 155–63.—The quality of porcelain enameled hollow ware is first judged by its appearance or eye appeal which is governed by design, color, brilliance, and quality of workmanship. Durability may be judged in the laboratory by resistance to mechanical shock, thermal shock, and fruit acids. A review of the literature on the physical testing of enameled hollow ware is included. Particular emphasis is given to practical methods of making tests and the effect of such variables as metal preparation, gage, enamel thickness, and firing range on the results obtained. F.J.Z.

Pickling of hollow ware. B. T. SWEELY. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 145–48; *Second Forum, Oct., 1937*, pp. 90–101.—S. discusses iron sulfide pickling of hollow ware and the methods of control. A number of figures augment the paper. F.J.Z.

Porcelain enameling installation for production of Coldspot refrigerators. S. JUDD. *Ind. Heating*, **5** [3] 247–51 (1938).—Drying ovens for the ground coat and cover coat are described. They are of the gas-fired radiant-tube type which is of special advantage here as combustion takes place inside the tubes and therefore no combustion products are present in the furnace atmosphere. M.H.

Porcelain enamel protects all-steel produce rack. TOLEDO PORCELAIN ENAMEL PRODUCTS CO. *Steel*, **101** [5] 56 (1937).—An all-steel produce rack is completely finished with porcelain enamel. Not only the face but also the structural framework and drain pans are completely coated with this finish. The rack is white, trimmed with black, and the produce trays are finished with a lettuce green acid-resisting enamel. Illustrated. H.E.S.

Porcelain enamel unit construction as it pertains to refrigerators. F. L. MICHAEL. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 121–29.—Advantages of a one-piece cabinet exterior from an enameling standpoint are (1) a more simplified problem of color matching; (2) elimination of many hazards connected with assembly of the panel-type cabinet; (3) reduction in the amount of wiping and brushing of cover coat from flanges and edges which is necessary in the panel-type cabinet; and (4) elimination of the prefabricated shell necessary in the panel-type cabinet. The disadvantages lie in the necessity of replacing the entire case when a defect occurs after the cabinet has been assembled or of reworking the entire case when a defect occurs during enamel application. F.J.Z.

Portland cement as a binder for foundry molding sand. C. A. MENZEL. *Trans. Amer. Foundrymen's Assn.*, **8** [4] 200–24 (1937).—M. studied the type of cement and cement content, moisture content, type of sand, extent of ramming, temperature and age of mix, etc. The results obtained indicate the general feasibility of using Portland cement as a binder in molding sand and provide a basis for suggestions and recommendations for this use. H.E.S.

Practical sand control in gray iron foundries. H. A. DEANE. *Trans. Amer. Foundrymen's Assn.*, **8** [2] 615–25 (1937).—To obtain sound castings free from surface defects, sand control is a necessity. Laboratory tests are of value in selecting new sands and daily control tests should include those for moisture, permeability, and strength, with records kept and studied. Varieties of molding sands used should be kept to a minimum. Data on properties of sands for various classes of castings are listed, and methods of making additions, both of natural and synthetic materials, are given. Proper temper is stressed and facing control is described. H.E.S.

Preparation of castings for enameling. M. L. CARL. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 134–41.—C. describes some of the causes for the more common troubles experienced in enameling castings. F.J.Z.

Present status of enameling technique. L. VIELHABER. *Z. Ver. Deut. Ing.*, **81** [34] 982–84 (1937).—V. reviews ground and cover enamels, powder enamels, mixing, and the influence of the shape of the piece to be enameled. A ground enamel for sheet steel is composed of borax 55, feldspar 37, quartz 31, calcined soda 11, fluorspar 5, calcite 5, soda saltpeter 2.5, cobalt oxide 0.5, and MnO_2 0.5 parts by weight. A white enamel comprises borax 58, feldspar 100, quartz 10, calcined soda 10, fluorspar 10, cryolite 9, sodium fluosilicate 9, and soda saltpeter 5 parts by weight. A powder enamel for bathtubs is composed of borax 28.8, feldspar 28.8, quartz 11.3, calcined soda 9.3, fluorspar 3.2, cryolite 3.2, saltpeter 4.8, antimony oxide 6.4, and zinc oxide 4.5 parts by weight. M.H.

Processing of leadless cast-iron enamels. E. C. PORST. *Proc. Porcelain Enamel Inst. Forum., First Forum, May, 1937*, pp. 141–45.—P. describes foundry operation and enameling practice at the G. D. Roper Corp. F.J.Z.

Production of one cover coat ware. HERMAN L. COOK. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 93–104.—C. has selected his material for this paper from papers on one-coat ware presented by twelve members of the industry. F.J.Z.

Properties of enamel slurry: II, Comparison of properties of slurries from two works. K. P. AZAROV AND N. M. SERDYUKOVA. *Zhur. Priklad. Khim.*, **11**, 257–60 (1938).—A difference in the conditions of preparation of enamel slurry of the same composition leads to a considerable difference in their properties. A high initial alkalinity of slurry, characterizing the solubility of the frit when grinding, leads to its increased thixotropy. The latter depends not so much on the addition of the electrolyte (potash) as on the amount of salts lixiviating when the grinding of salts is effected. Inferior properties are given to the slurry by an incomplete mixing up of the charge, a low melting temperature and a longer grinding period causing an increased solubility of the frit when ground. P.B. & E.S.

Properties of sheet metal. J. D. JEVONS. *Metal Ind.* [London], **51** [6] 127–31; [7] 157–61; [8] 181–84; [9] 207–10; [10] 227–31; [13] 310–13; [14] 335–40 (1937).—J. presents the measurement and specification of the properties which determine the behavior of sheet metal during drawing. H.E.S.

Range design has marked effect on finish durability and ultimate cost. ANON. *Steel*, **101** [15] 50–54 (1937).—The effect of design on the finish durability of stoves is pointed out, and many practical illustrations of good design are given and illustrated. Many excellent finishes have been ruined because poor design caused service stresses which made the finish crack and peel. H.E.S.

Reducing enamelware shipping losses. HOWARD A. WETTER. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 53–58.—W. suggests methods of reducing, both to the trade and to the carriers, shipping losses which occur during the transportation of vitreous enameled articles. This paper is presented from the transportation man's viewpoint. F.J.Z.

Reduction of acid and labor costs are prime factors in pickling research. ANON. *Steel*, **101** [21] 56, 74–75 (1937).—Good results were obtained by pickling enameling iron with iron sulfide followed by a nickel flash. Good adherence was also obtained by passing hydrogen sulfide gas into the sulfuric acid bath. H.E.S.

Requirements of porcelain enamel for architectural work. MILTON GALLUP. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 116–21.—Proper design and engineering, careful and exact fabrication, and proper packing and crating are some of the elements which enter into the cost of producing porcelain enameled steel for construction uses. F.J.Z.

Review of progress in the industry. EMERSON P. POSTE. *Proc. Porcelain Enamel Inst. Forum, First Forum,*

May, 1937, pp. 5–20.—P. presents a thorough review of the porcelain enamel literature comprising about 150 articles that appeared in various publications during the year 1936–37. F.J.Z.

Safety in the enamel plant. EDGAR L. ECKELS. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 41–45.—E. discusses the safety program of a large enameling shop with particular reference to instruction of new employees and the value of cleanliness and orderliness in the plant. F.J.Z.

Sand control in a malleable foundry. E. C. ZIRZOW. *Trans. Amer. Foundrymen's Assn.*, **8** [4] 134–56 (1937).—Factors of molding-sand control are listed, and an outline of the mechanical method of handling the molding and core sand is given. Charts present data on properties as variations over stated periods. H.E.S.

Shop problems involved in the manufacture of architectural porcelain enamel. A. C. WEIERICH. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 77–83.—W. reviews the preparation of working drawings, shop drawings, metal fabrication problems, enamel plant problems, and customer service as required of the manufacturer of architectural porcelain enamelware. A careful system of control is absolutely necessary for all steps in the process. F.J.Z.

Simple and practical incentive systems for enamel shops. R. M. JAMES. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 28–37.—An instructive and interesting discussion of wage and bonus systems is given. **Discussion of enameling in Holland.** J. SCHOTSMAN, *et al. Ibid.*, pp. 38–41.—Enameling conditions, products, and wages in Holland are discussed. F.J.Z.

Surface tension of vitreous enamel frits at and near firing temperatures. WILLIAM N. HARRISON AND DWIGHT G. MOORE. *Jour. Research Nat. Bur. Standards*, **21** [3] 337–46 (1938); R.P. 1133. Price 5¢.—A method is described for measuring at high temperatures the surface tension of liquids with viscosities as high as 10,000 poises. It consists in weighing the portion of the liquid supported by the meniscus adhering to a platinum cylinder, the bottom edge of which is at the level of the undisturbed surface of the liquid. The method insures a zero angle of contact and eliminates the necessity of determining the specific gravity of the sample at the temperature of test. Results were in good agreement with those obtained by the bubble-pressure method on molten sodium chloride and also on a molten "soft" ground-coat frit at a viscosity of 400 poises. The results obtained on 8 typical commercial vitreous enamel frits at 850°C showed, with one exception, maximum differences of less than 10%. The mean value for 7 of the frits was approximately 250 dynes/cm., while that for a high lead composition was about 200 dynes/cm. The surface tension in all cases increased with decreasing temperature between 925° and 775°C, the maximum increase being less than 10%. Mill additions had very little effect on the surface tension. See "Consistency—," *Ceram. Abs.*, **17** [4] 134 (1938). R.A.H.

Symposium on synthetic earths in the foundry: Form sands for the foundry. G. TAROCCHI. *Ind. Meccan.*, **20** [8] 692–98 (1938). **Synthetic earths in the modern foundry.** V. S. PREVER. *Ibid.*, pp. 698–703.—Properties required in a foundry sand, available Italian sands for this purpose, their preparation, and Italian practices are discussed. M.H.

Symposium on testing of enamels. W. N. HARRISON. *Proc. Porcelain Enamel Inst. Forum, First Forum, May, 1937*, pp. 38–46.—The approach of the Standards Committee of the Porcelain Enamel Institute's Technical Research Section toward the establishment of test methods is based largely on the classification of tests according to the purposes for which they are used and the attempt in each case to meet the requirements of the situation. Thus, tests may be applied to products, process control, and materials. They may also be intended for (*a*) use within a given organization; (*b*) exchange or publication of results, merchandizing, purchase specifications, and similar uses; and (*c*) research and development. H. presents the Institute's pamphlet on the tentative standard tests for acid resistance. F.J.Z.

System copper–nickel–iron. W. KÖSTER AND W. DANNÖHL. *Z. Metallkunde*, **27**, 220–26 (1935); *Met. Abs.* (in *Jour. Inst. Metals*), [2] **3** [1] 4 (1936).—The ternary diagram and several pseudobinary sections through it have been constructed from the results of thermal analysis, magnetometric measurements, and determinations of the electrical resistance. The boundary of the field in which the α–γ transformation occurs is a straight line joining the copper corner of the ternary diagram with 28% nickel on the iron-nickel side. The miscibility gap in the iron–copper system is gradually closed by addition of nickel, disappearing entirely with 27% nickel at 1220°C and with 82% nickel at room temperature; hence, alloys within this range are amenable to precipitation-hardening treatment, which in certain alloys containing about 50% nickel leads also to changes in the Curie point.

Titanium white in enamel to improve its acid stability. WALTER OBST. *Emailwaren-Ind.*, **14** [38] 264–65 (1937)—O. discusses a series of patents dealing with the use of titanium white or TiO_2 to increase acid stability. M.V.C.

Treatment of iron surfaces before enameling. VIELHABER. *Emailwaren-Ind.*, **15** [23–24] 163–64 (1938).—To obtain a white ground enamel coat, the iron surface must be pure or free from any impurity and the nickel coat must be uniform and must cover the iron surface entirely. The cleaning of iron surfaces is briefly discussed. M.V.C.

Trichlorethylene degreasing process in electroplating. ANON. *Chem. Trade Jour.*, **101**, 30 (1937).—Electrolytic alkali cleaning, followed by a cyanide dip, is still the most efficient method of removing stains and oxides. L.R.B.

Use of anhydrous sodium silicate in the founding of the second fusion. A. D. *Verre & Silicates Ind.*, **9** [11] 128 (1938).—To reduce the percentage of fused metal passing into the slag in founding, the slag must be made as liquid as possible by the addition of a suitable flux. Anhydrous sodium silicate appears to be an ideal flux as it melts at 750°; it is very liquid and is an active desulfurizing agent. The addition of 5 to 10% of the weight of the flux of neutral vitreous sodium silicate in powder or small pieces permits a gain in time and fuel, and the slag obtained can be used in the manufacture of paving block. M.V.C.

Use of sodium silicate in metallurgy. ALBERT DEBECQ. *Verre & Silicates Ind.*, **9** [23] 270–71 (1938).—Sodium silicate in metallurgy is used for (1) refractory coatings; (2) founding nonferrous metals and alloys; (3) tempering; (4) cementation; (5) electrochemical cleaning of metals; (6) electric welding; (7) agglomeration of dust of blast furnaces; (8) founding ladles; and (9) reducing oxidation in casting steel; the upper part of ingot molds is covered with a vitreous coating of finely powdered neutral anhydride sodium silicate (fusing point 750°) either alone or mixed with inert materials. M.V.C.

Washing machine tubs finished with porcelain enamel. HORTON MFG. CO. *Steel*, **100** [22] 65 (1937).—Porcelain enamel on washing machines has proved attractive to housewives because of its appearance, its long life, and the ease with which it can be cleaned. An explanation of manufacturing processes in a modern plant is given. Illustrated. H.E.S.

Welding. WALTER W. PETRY. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 46–50.—P. discusses the relative merits and disadvantages of acetylene welding, resistance welding, and metallic and carbon arc welding as applied to metal for porcelain enameling. F.J.Z.

What happens to a core in a core oven. J. WILLSER. *Ind. Heating*, **5** [9] 823–26 (1938).—W. discusses the factors affecting the firing of cores, such as dryness, relative humidity of the atmosphere, and the amount of heat required. M.H.

Workable control systems and benefits to the enamel plant. J. E. HANSEN. *Proc. Porcelain Enamel Inst. Forum, Second Forum, Oct., 1937*, pp. 4–21.—The production of porcelain enamel finishes involves not only

thermal treatment to fuse the finishing material to a glassy coating but also proper preliminary preparation of the surface upon which the enamel slip is applied, proper preparation of the enamel slip in regard to fineness of grind and consistency, and proper methods of application; in each of these operations control must be practiced to obtain good results and economy. H. stresses the importance of control in all the operations involved from the purchase of the raw materials, pickle- and mill-room practice, processing, and material specifications to the final inspection of the finished ware. F.J.Z.

PATENTS

Composition for degreasing and conditioning of surfaces and process of manufacture. BENNETT (HYDE), LTD. Brit. 493,611, Oct. 26, 1938 (Jan. 11, 1936).

Enameled article. J. T. PENTON. U. S. 2,130,631, Sept. 20, 1938 (Feb. 17, 1936). A vitreous enameled metallic base and a part of rust-resistant metal to which vitreous enamel will not readily adhere welded directly to the base to facilitate the connection of the base with an object.

Enameling of articles made of cast iron. WALTER ECKHOFF. Ger. 662,727, June 23, 1938 (March 9, 1934); VI/48*c*. 1. The various layers of enamel are applied in the moist ground state to the surfaces to be enameled and are fired on. The basic and top enamel layers are fired on simultaneously with equal or nearly equal temperatures. D.A.B.

Faced building element. KARL TÜRK (Porcelain Enamel & Mfg. Co.). U. S. 2,135,544, Nov. 8, 1938 (Aug. 31, 1936).

Firing oven for enameling shield-shaped material. SEBASTIAN HERBST (Brown, Boveri & Cie, A.-G.). Ger. 663,939, July 28, 1938 (Nov. 9, 1936); VI/48*c*. 7. The firing oven is provided with firing supports having springs and interchangeable points in the glowing chamber. The firing supports are constructed as single supports, which, independent of each other, are adjustable by degrees from outside the oven. D.A.B.

Making tubs. C. J. RODMAN (Steel Sanitary Co.). U. S. 2,135,877, Nov. 8, 1938 (April 27, 1934).

Producing a white base or white enamel. IGNAZ KREIDL. Ger. 663,278, July 7, 1938 (Jan. 24, 1931); VI/48*c*. 1. Before enamel coating the metal, especially iron, a salt solution of one or more adhering metals is applied to the upper surface of the metal to be enameled, and this applied coating is changed by transformation into compounds or complexes of adhering metals which are insoluble in aqueous solution. Concentrated salt solutions of adhering metals, with the exception of phosphate solutions, are advantageously used, and the transformation is brought about by drying with heat or by firing. D.A.B.

Producing white mottled enamel. IGNAZ KREIDL. Ger. 657,538, Feb. 24, 1938 (Oct. 23, 1935); VI/48*c*. 2.02. White mottled enamel, especially with iron-enameling processes, is produced by the addition of gas mottling materials. The mottling agent, which upon gasification leaves behind a colored precipitate, and compounds of metals such as Fe, Sb, Ce, U, and As (especially their oxides or compounds of their oxides with other metallic oxides) are added to the batch; these materials are used in a small quantity, less than 1% being desirable, so as not to influence the characteristic mottling. The metallic compounds are either added to the mill or melted with the raw materials. D.A.B.

Support for firing enamel in an electrically heated enamel oven. SEBASTIAN HERBST (Brown, Boveri & Cie A.-G.). Ger. 663,279, July 7, 1938 (Oct. 27, 1936); VI/48*c*. 7. A support for firing enamel on ovens and troughs consists of flexible chains which draw the material to be fired into the heating chamber and which run the length of the unit. Articles with variably shaped bottoms, such as troughs and tubs, are drawn into the heating chamber and automatically removed. D.A.B.

White opacifiers for enamels and glazes. DEUTSCHE GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Brit. 490,986, Sept. 7, 1938 (Dec. 9, 1936).

Glass

Abnormal case of birefringency caused by compression of a transparent substance. A. COTTON, GEORGETTE COURTOT, AND JACQUELINE GUILLEMIN. *Compt. Rend.*, **207** [5] 313–15 (1938).—Plexiglass (refractive index about 1.49 and density 1.18) shows, under pressure, a behavior like that of glass and becomes negative uniaxial; after the pressure is released the material is still birefringent but behaves now as positive uniaxial, a fact which has never been observed before. This is caused by structural deformation under compression. The experiments are described at length. M.H.

Aging of quartz lamps. E. HASCHÉ. *Elektrotech. Z.*, **59** [5] 119–20 (1938).—Many factors cause "aging" of quartz tubes, *i.e.*, slow decrease in efficiency of producing ultra-violet rays. The defect is mostly caused by blackening of the glass, due to small amounts of gas from the metal electrodes, impurities in the mercury, or dust and vapor on the outside. L.E.T.

Apparatus for determining breaking strength. E. REXER. *Glastech. Ber.*, **16** [8] 263–66 (1938).—R. describes an apparatus for making measurements on small rods and fibers with an accuracy of ± 1% on individual determinations. J.F.H.

Apparatus for determining the electrical volume resistivity of insulating glasses. E. SEDDON. *Jour. Sci. Instruments*, **15** [7] 226–31 (1938).—A null method of measuring the electrical resistivity of insulating materials is described. The current through the material is balanced against the current required to maintain, at a constant potential, a condenser whose capacity is being steadily diminished. A Lindeman electrometer is used to indicate the balance. The resistivities of glass specimens, maintained under controlled vacuum and temperature conditions, can be measured up to 10^{15} ohms with an accuracy of 5%. Illustrated. J.L.G.

Application of colloidal graphite to glass bottle molds J. S. MARSHALL AND W. G. MACKAY. *Jour. Soc. Glass Tech.*, **22** [91] 214–17 (1938).—The difficulty of forming a "skin" on new molds is overcome by the use of a colloidal suspension of graphite in the form of Aquadag paste mixed with distilled water in the proportions of one part in ten by volume. Aquadag is superior to Oildag in this respect. The graphite coating is applied at 100° before the molds are put in service, and the surface so formed is not easily broken by mechanical means. Below the graphite covering layer, there is a graphoid film on the metal surface which resists severe scraping. None of the surfaces treated with graphite show damage due to cracking or flaking. Swabbing of the molds in operation is practically eliminated. See "Parting—," *Ceram. Abs.*, **16** [3] 88 (1937). G.R.S.

Application of fused silica in heating processes. B. MOORE. *Ind. Chemist*, **13**, 502–506, 513 (1937).—B. describes the application and use of fused silica in acid concentration plants, preheating, cooling, and condensing units, reaction plants, distillation plants, furnaces, pumps, and electrical equipment. See *Ceram. Abs.*, **16** [10] 309 (1937). H.E.S.

Application of nickel alloys in glass manufacture. ANON. *Verre & Silicates Ind.*, **9** [11] 122–25 (1938).—Metallurgical products are used in glass manufacture as follows: (1) In apparatus used for the manipulation of glass during preparation, *e.g.*, for conveyers, casting ladles, puddlers and stirrers, and blowpipe ends, chrome nickel alloys fill the requirements satisfactorily and are now universally used. (2) Shaping and molding equipment, which includes matrices, mandrels, and the pieces used for molds, and drawing and molding machines, where the parts come in contact with the glass, are made of alloys containing a rather high nickel content because of its heat-resisting

qualities. (3) In metal parts of fusing furnaces, generators, and annealing furnaces which come in contact with the batch and which must resist heat and contact with the glass, nickel alloys are superior; nickel alloy recuperators are better than those made of refractory clay. (4) Nickel alloys are used for other apparatus and equipment in the handling of glass. As certain complex nickel alloys have the same expansion coefficient of glass they are used for jointing glass and metal and for reinforcing glass. M.V.C.

Behavior of various kinds of saltpeter in the glass melt. F. H. Zschacke. *Sprechsaal*, **71** [12] 151–52; [13] 163–64; [14] 173–74 (1938).—Z. determined the rate of disintegration on heating at different rates of temperature increase of sodium, potassium, and barium nitrates mixed with sand or quartz powder. The disintegration temperatures of potassium nitrate alone or mixed with sand or quartz powder are much higher than those of sodium and barium nitrates. Gases predominating during disintegration of alkali nitrates are oxygen and nitrogen, whereby considerable amounts of nitrates evaporate. Gases produced by barium nitrate consist chiefly of nitric oxide; evaporation of barium nitrate has not been observed. Experiments showed that the purifying effects of potassium nitrate and barium nitrate (used in the same amounts) are equal, while sodium nitrate has a much weaker effect. The weaker purification effect of sodium nitrate is accounted for by its low disintegration temperature, while the great purification effect of barium nitrate is due to a slow separation of decomposed nitric oxide at higher temperatures. M.V.C.

Boric acid and zinc oxide as secondary glassforming materials. F. H. Zschacke. *Glashütte*, **68** [14] 255–56 (1938).—Secondary glassforming materials affect some properties of the finished glass, such as workability, devitrification, chemical stability, and color. Boric acid is the most important among them. Z. describes experiments which show that zinc glass is less stable than boric acid glass and that the replacement of boric acid by the same amount of zinc oxide lowers the stability of the glass. The replacement of boric acid by Sioto, an artificial flux, increases the glass stability somewhat. Didymium oxide has the same effect. Sioto improves chemical stability more than borax and zinc oxide; the former improves the rate of melting only. See *Ceram. Abs.*, **17** [1] 14 (1938). M.V.C.

Calculation of rates of displacement in viscous bodies under applied stress. R. W. Douglas. *Jour. Soc. Glass Tech.*, **22** [91] 206–13 (1938).—The analogy which exists between the slow steady motion of a viscous body and elastic displacement has been used to derive the equations for the rates of distortion of heated glass cylinders under pressure. The calculations were verified experimentally. G.R.S.

Cementing glass and mirrors to wood and metal. G. Schieb. *Österr. Glaserztg.*, **3**, 68–70 (1938).—Large pieces of glass require an elastic intermediate layer, such as felt, fabric, or cork sheets, when applied to wood. The use of cork sheets is the best technique known to S. The following adhesive compositions are suggested: (1) for zinc, 200 g. gelatine, 150 g. water, 50 g. acetic acid, 50 g. 90% alcohol, and 50 g. powdered alum; (2) for tin, flour paste; (3) for nickel, 500 g. light dextrin in 400 g. water, 10 g. alum, and 20 g. cream of tartar in 200 g. water; and (4) for aluminum, 100 g. casein, 10 g. caustic soda, 20 g. slaked lime, 170 g. water, and small additions of Na_2SiO_3. It is generally necessary to etch or otherwise prepare the metal surface. For glass-to-glass joints, the following timeproven compositions are useful: (1) 5 g. cellulose acetate, 10 g. methyl alcohol, and 100 g. tetrachloroethane; (2) 75 g. gum rubber, 15 g. gum mastic, and 60 g. chloroform; and (3) 200 g. casein, 40 g. ammonia, and 1000 g. water. J.F.H.

Characteristic crack formation of sheet glass. Anon. *Sprechsaal*, **71** [6] 78–81 (1938).—The formation of cracks and their causes are discussed in detail. Illustrated. M.V.C.

Chemical stability of glass windowpanes manufactured according to the Fourcault method. N. I. Samsonov. *Keram. & Steklo*, **14** [4] 32–34 (1938).—No clear relationship was observed between the lowering of the chemical stability of glass and the increase of its alkali content. The cause of the low chemical stability and rapid weathering of some glasses manufactured according to the Fourcault method is the fact that sodium sulfate instead of soda was used for melting them. M.V.C.

Coloring effects of radiation on phosphate glasses. J. Hoffmann. Translated in *Glass*, **14** [12] 519–20, 522 (1937); see *Ceram. Abs.*, **17** [5] 180 (1938). B.C.R.

Constitution of glass. W. Büssem and W. Weyl. *Naturwissenschaften*, **24** [21] 324–31 (1936); abstracted in *Physik. Ber.*, **17** [17] 1558 (1936).—Views of the nature of glass are critically reviewed whereby the chemical nature of glass becomes less important; instead, the phenomena which occur during transition from the brittle to the viscous state of the glass are emphasized. The anomalies in the properties observed are considered the characteristics of the vitreous materials. These views are discussed from the viewpoint of the mineralogist and research scientist in structure, thermodynamics, etc. M.H.

Crystal-chemical relation between germanium and silicon. Wolfram Schütz. *Z. Physik. Chem.*, **B31**, 292–308 (1936).—The crystal-chemical relation between silicon and germanium in pairs of corresponding crystalline combinations and glasses is discussed. Exposures with a Debye camera made on three pairs, Zn_2SiO_4-Zn_2GeO_4, Be_2SiO_4-Be_2GeO_4, and Cs_2SiF_6-Cs_2GeF_6, make isomorphism appear highly probable. Observed and calculated intensities ($\sin^2 \varphi$ values), density, etc., for the above natural and synthetic compounds are shown. A series of 10 lead-silicate and lead-germanium glasses was prepared. While it is only possible to obtain pure Pb-Si glasses (free from devitrification) with a maximum lead content of 79% PbO, a heavy lead-germanium glass (81.15% PbO and 18.85% GeO_2) can be made which has a density of 6.92 and is very close to the orthoglass $2PbO \cdot GeO_2$. Data on chemical composition, light transmission, refractive quotient, and density of these glasses are presented. 8 tables. L.E.T.

Czechoslovak glass-grinding sands. Z. Schaefer. *Sklářské Rozhledy*, **15**, 152–60 (1938).—Practical grinding tests show that sand for grinding glass should be of uniform grain size (maximum 0.5 mm.), rounded grains being more efficient than sharp-edged fractured grains. Soft mineral constituents, chiefly clays, greatly reduce the grinding power. E.P.

Deposits in glassmelting furnaces. W. *Keram. Rundschau*, **46** [17] 189–92 (1938).—W. describes the action of the batch dust on furnace and checker brick and deals with the formation of sodium sulfate in glass furnaces and the defects caused by it. Analyses of deposits in cool parts of the furnaces are given. 16 references. F.E.V.

Determination of elastico-optical constants from diffraction experiments. L. Bergmann and E. Fues. *Naturwissenschaften*, **24**, 492 (1936); *Brit. Chem. Abs.-B*, **55** [47] 1093 (1936).—A method is described for determining the elastico-optical constants of glass by investigating the diffraction spectra and position of the plane of polarization when a beam of polarized light is passed through a glass cube vibrating at high frequency. The theory of the method is given. See *Ceram. Abs.*, **17** [5] 177 (1938).

Determination of free selenium in selenium-red glass. S. Shinkai and Y. Hamazaki. *Jour. Soc. Chem. Ind. Japan*, **41** [4] 94B (1938).—The components of ordinary selenium-red glass are SiO_2, Al_2O_3, Fe_2O_3, ZnO, CdS, B_2O_3, and alkali. The following method is based on the fact that if the ordinary red glass given above is treated with hydrofluoric acid, free selenium is precipitated completely but all other components are soluble in the acid. About 1 g. of the finely powdered sample is weighed into a platinum dish and moistened with water; 20 to 33 cc. pure concentrated hydrofluoric acid are added and stirred with a platinum wire until dissolved. The solution is then cooled with running water, and boric acid is added to make the free hydrofluoric acid inactive to glass. The precipitated selenium is filtered through a weighed glass filter, dried at

105° to 110°C, cooled in a desiccator, and weighed. The results are given in a table. M.V.C.

Determination of the pendulum hardness of glasses. W. SCHMIDT AND H. E. VON GRONOW. *Glastech. Ber.*, **14** [1] 23–36 (1936).—The apparatus consisted of a symmetrical beam with weights attached to the ends and was supported by a knife edge of Widia metal (2 mm. long with a radius of curvature of 0.5 mm.) on the surface to be tested. The work of deformation is measured by decrease in amplitude of vibration. The polished glass plates, 3 mm. thick, were mounted on a metal base with wax for testing. The initial amplitude of vibration in all cases was 210 mm. Measurements were made after 6, 12, and 18 min. Most of the 28 glasses measured were made up from a base glass of the composition 18% Na_2O and 82% SiO_2 by replacement of SiO_2 with other oxides. Addition of 3% Al_2O_3 has about the same effect as 10% MgO, and differences with 5 or 10% MgO are slight. A series of B_2O_3 glasses shows a maximum hardness at 12% which corresponds to maxima in many other properties. Glasses with 5, 10, and 15% CaO are harder than corresponding BaO-containing glasses. The hardness of a series of PbO glasses increased regularly to 20% PbO and dropped sharply with a 5% increase in the PbO content. The pendulum hardness increases very markedly with increasing CaO content and there is a definite parallelism with other strength properties. In a base glass of 60 SiO_2, 20 BaO, 20% Na_2O, by replacement of Na_2O by K_2O gives a maximum hardness at 10% K_2O. The effect of ZnO on hardness was similar to that of MgO. J.F.H.

Developing electric glassmelting furnaces. F. S. E. *Keram. & Steklo*, **14** [5] 7–10 (1938).—E. discusses arc, resistance, and induction furnaces and gives patent literature. M.V.C.

Effect of ammonium sulfate on the physical and chemical processes in the fusion of sodium-lime-silica glass. M. A. BEZBORODOV AND N. O. ABELCHUK. *Zhur. Priklad. Khim.*, **11**, 234–51 (1938).—The effect of an addition of 1% of ammonium sulfate was investigated in a mixture of Na_2SO_3, $CaCO_3$, and SiO_2. Ammonium sulfate melts and dissociates at about 250°C. The mixture of dry soda with ammonium sulfate begins to react at the fusion and dissociation temperature of the sulfate. In a mixture with moist soda the reaction is evident at room temperature. If moisture is eliminated, the reaction becomes slower or stops under 250°. In a mixture of $CaCO_3$ and $(NH_4)_2SO_4$, the reaction takes place in a similar manner. With a 1% addition, $(NH_4)_2SO_4$ transforms partially to sodium sulfate and partially to calcium sulfate. The reaction begins at 250° in a dry mixture and at low temperatures in moist mixtures. Above 250° it takes place owing to the thermal dissociation of $(NH_4)_2SO_4$. At the temperature of formation of silicates (300° and over) soda gives a greater amount of silicates when it is not regularly expanded over all the surface of SiO_2 and when it is found in the mixture in separate grains. P.B. & E.S.

Effect of various salts on the rate of polishing of optical glass. B. N. MOSKVIN. *Optiko-Mekh. Prom.*, **7** [5] 10–13 (1937); abstracted in *Referat. Silikatliteratur*, **5** [5] 5238 (1938).—The fact that the surface of every glass is coated by a layer containing water whose thickness depends on the composition of the glass indicates that the polishing time may be influenced by the presence of various salts in the polishing solution. Tests showed that the polishing process was markedly promoted when the polishing solution contained $FeCl_3$, $FeCl_2$, $FeSO_4$, $ZnSO_4$, or $ZnCl_2$. M.V.C.

Electrical properties of solids: I, Experimental methods. RAYMOND M. FUOSS. *Jour. Amer. Chem. Soc.*, **59** [9] 1703–1707 (1937).—A method of determining absolute values of dielectric constants of solids is described. F. discusses errors due to imperfect contact between sample and electrodes and explains a method of eliminating them. Results on two amorphous solids, fused quartz and Pyrex brand glass, illustrate the method. The dielectric constant of fused quartz is 3.810. Pyrex glass at 500~ has the following constants: $\epsilon' = 4.810$, $\tan\delta = 0.010$ at 25°C, and $\epsilon' = 5.185$, $\tan\delta = 0.042$ at 100°C. Illustrated. F.G.H.

Examination of ceramic or analogous materials. OTTO MANFRED. *Verre & Silicates Ind.*, **9** [27] 319 (1938).—Research on the internal constitution and fine structure of materials combined with technico-mechanical tests now used for controlling the manufacture of new products gives valuable information for the optimum utilization of ceramic materials. The fact that the modulus of elasticity of glass is 640,000 kg./cm.^{2} and that of celluloid is 25,000 shows clearly the different fine structures of the two materials. The certainty of the fine crystalline structure of cellulose makes it impossible to admit the crystalline character of glass in spite of certain interpretations of experiments. M.V.C.

Filtered ultra-violet rays in ceramics and glassmaking. CARLIER. *Verre & Silicates Ind.*, **9** [21] 245 (1938).—The analysis of a large number of bodies can be defined by the study of the absorption of ultra-violet rays. Glasses which are opaque to ultra-violet rays are transparent to ordinary light, while a very thin foil of pure silver is permeable to certain ultra-violet rays and impermeable to light rays. Absorption of ultra-violet rays is a question of molecular composition. Luminescent substances possess the power of spontaneously emitting luminous rays when subjected to the action of an illuminating source. This luminescence is present in two aspects, phosphorescence and fluorescence. Phosphorescent bodies differ from fluorescent bodies in that, after the luminous source has ceased to light them, they can continue to emit luminous rays for a long time. Fluorescent bodies emit luminous rays only when illumined by the light source. Many substances present fluorescences varying in color and intensity which are particularly characteristic when the light source is that of ultra-violet rays filtered to line 3.650 which is called Wood's light. In ceramics, Wood's light is used to make a qualitative analysis more rapidly and simply than by a chemical method. In glazes, heavy coloring oxides such as cobalt, chromium, manganese, and uranium are used and they can be recognized by their characteristic fluorescence. Wood's light shows the differentiation between kaolin and clay, the influence of furnace gas on glaze which permits the control of the furnace atmosphere, and the cause of yellow coloring of glaze and white porcelain. M.V.C.

Fining of glass melts by sound waves. V. KLEIN. *Glastech. Ber.*, **16** [7] 232–33 (1938).—The practical application of this method presents many engineering difficulties. Its successful operation should be economical. F. KRÜGER. *Ibid.*, pp. 233–36.—A sample of violently shaken glycerine was practically freed of bubbles in 5 min. by introducing an oscillator vibrating at a frequency of around 16,000 Hz. A control sample remained essentially unchanged. In applying the method to glass, a platinum crucible surrounded by a platinum resistance furnace was placed on an iron bar mounted vertically on a water-cooled magnetostriction oscillator. Samples were heated $^1/_2$ hr. at 1350°C with and without vibration. The fining action was very marked. The vibration causes coalescence of fine bubbles and should also promote the release of dissolved gases. J.F.H.

Fire resistance of glass brick. ANON. *Pottery & Glass Record*, **20** [8] 202 (1938).—A panel of glass brick made by Pilkington Brothers, Ltd., has successfully passed a fire-resistance test at the Fire Testing Station of the Fire Offices Committee. It resisted the passage of fire for 1 hr. without developing cracks or fissures through which flame could pass. The maximum temperature reached was 950°C, and the average was 920°C. Each brick measured $5^3/_4 \times 5^3/_4 \times 3^7/_8$ in., weighed 7.74 lb., and was cast in two halves and joined by molten aluminum. A.B.S.

Glass blocks—the future of the glazer's trade. G. SCHIEB. *Österr. Glaserztg.*, **3**, 70–71 (1938); see *Ceram. Abs.*, **17** [6] 215 (1938). J.F.H.

Glass chipping, new glassworking technique. G. SCHIEB. *Österr. Glaserztg.*, **3**, 71–73 (1938).—Excellent decorative effects can be obtained by chipping the glass surface with a sharp tool. J.F.H.

Glass grinding in America. G. S. *Deut. Glaserztg.*, **49**, 3–4 (1938).—S. describes machines for edge-grinding and bevelling plate-glass sheets and mirrors. He states that the cost of such grinding is only a quarter of the cost in Germany but that the quality is inferior. E.P.

Glass state and artificial resins. E. JENCKEL. *Naturwissenschaften*, **25**, 497–500 (July 30, 1937); abstracted in *Science Abs.-A*, **40** [478] 1070 (1937).—J. discusses the nature of the transformation interval of the artificial resins, leading to the conclusions (1) that these resins, or at least those that soften by heat, are to be regarded as in the glassy state; (2) that the transformation interval is a "freezing-in (einfrier) temperature" and it should therefore be possible to modify their physical properties by varying the rate of cooling; and (3) that the increase in strength resulting from slight deformation resembles the strengthening of metals by cold-working. H.K.R.

Glass strength in relation to form. A. THUM. *Glastech. Ber.*, **16** [8] 266–69 (1938). J.F.H.

Glass wool in phenoplastics. ANON. *Kunststoffe*, **26** [11] 234 (1936).—The use of glass wool as a substitute for asbestos was recently advanced in technical literature as a filler for phenoplastics. Technical research in this field shows that this substitution is impractical, as the rolling process causes the glass wool to lose its fibrous structure and converts the wool into glass dust. D.A.B.

Heat capacities of selenium crystals, selenium glass, and tellurium at low temperatures. C. TRAVIS ANDERSON. *Jour. Amer. Chem. Soc.*, **59** [6] 1036–37 (1937).—A. determined the heat capacities of selenium crystals and tellurium from about 50° to 300°K and calculated their corresponding entropies as 10.49 and 12.85, respectively. Measurements for selenium glass over the same range indicate the difference in entropy from 0° to 298.1°K to be 11.15. Illustrated. See *Ceram. Abs.*, **15** [10] 314 (1936). F.G.H.

High-frequency cinematographic investigation of the breaking process in glass. H. SCHARDIN AND W. STRUTH. *Glastech. Ber.*, **16** [7] 219–27 (1938).—The photographic apparatus used has been previously described by C. Cranz and H. Schardin (*Z. Physik*, **56**, 147–83 (1929)). The breaks were started in most cases by a rifle shot fired at an angle of 20° to the glass plate surface. The circular patterns and the linear relation between length of cracks and time establish the constancy of the velocity of propagation. Frequency variations of the spark of 5% were possible. An average value was obtained by photographing bullets. Some cracks stop and continue again with the same velocity. The following are values of the velocity (m./sec.): 2 mm. window glass 1520; 4 mm. plate glass 1550; 5 mm. plate glass 1550; 5 mm. Securit glass 1550; 7 mm. plate glass 150; two-layer safety glass 1500; 20 mm. armor glass 1420; and 4 mm. vitreous silica 2200. J.F.H.

Importance of industrial glass in production and use. H. MAURACH. *Glastech. Ber.*, **16** [8] 251–58 (1938). J.F.H.

Infra-red spectrum and the structure of silicates and glasses. F. MATOSSI. *Glastech. Ber.*, **16** [8] 258–63 (1938).—The crystal structure of silicate is determined by the tetrahedral SiO_4 grouping which may be isolated or linked together by the sharing of 1 to 4 O atoms. The infra-red reflection spectrum (% reflection plotted against wave length) gives information concerning the extent of this linking. There is a systematic displacement of characteristic bands toward shorter wave lengths in going from an isolated tetrahedral structure, as in titanite through diopside (chain structure), to a more highly polymerized structure, as in albite. In a series of BaO-SiO_2 glasses the position of the maximum shifts from 9.37 μ to 10.4 μ as the ratio of BaO/SiO_2 is increased from 0.42 to 1.36. A maximum occurring at about 12.5 μ in the spectra of crystalline silicates is ascribed to a ring structure of 4 to 6 tetrahedra. As the spectra of vitreous silica and crystalline quartz also show this band, the existence of crystallites in vitreous silica is disclosed. See *Ceram. Abs.*, **17** [4] 138 (1938). J.F.H.

Lining of large liquid containers. G. SCHIEB. *Österr. Glaserztg.*, **3**, 67–68 (1938).—Glass-lined vats have long been used for wine and should find wide use in other industries. The glass tile should not be larger than 20 x 20 cm. A mortar of 3 parts quartz sand, 1 part Portland cement, and 1/100 part Na_2SiO_3 (of the weight of sand) is satisfactory. The tile are spaced for luting. J.F.H.

Magnitude of the surface of glass powders: II. E. BERGER AND W. GEFFCKEN. *Glastech. Ber.*, **14** [12] 441–56 (1936).—The reproducibility of results, using the powder method of determining chemical stability of glasses, is around ±5% when carried out by the same experimenter. Results from various laboratories may vary as much as 100%. The factors affecting magnitude of surface in the preparation of samples were studied in detail. Surfaces were characterized by (1) average grain size per cubic centimeter, (2) projection surface (projecting light through the powder to a photocell), (3) acid solubility, and (4) iodeosin method. Uncertainties regarding absolute values, however, still remain. Errors can be minimized by observing the following precautions. The initial glass should not be of unusual shape; well-annealed thick plates are preferred. The mortar should not be too small, with a pestle which can approach the body of the mortar no closer than 2 mm. on impact. After one or at most two impacts the glass is given preliminary sieving for $^1/_2$ min. and the operation is repeated. The preliminary sieve should have a coarser mesh than the main sieves. For the main sieving the powder is shaken on the coarser of the two screens for two 5-min. periods on a shaking machine with one cleaning of the material adhering to the screen. The screens should be checked from time to time by determining z (the number of particles per cubic centimeter) using the equation $z = \frac{1}{f_v} \cdot \frac{2 \cdot l_1^3 \, l_2^3}{l_2 - l_1}$, where $f_v = 0.62$, and l_1 and l_2 are the mesh dimensions in centimeters. The washing out of fine dust should be done with dry alcohol or ether with gentle shaking, and conglomerate pieces are removed with tweezers. For Part I see *Ceram. Abs.*, **15** [4] 118 (1936). J.F.H.

Manufacture of glass wool from molten glass. M. G. CHERNYAK AND M. S. ASLANOVA. *Keram. & Steklo*, **14** [4] 23–32 (1938).—A brief review is given of the properties of glass wool, and attempts to manufacture it in Russia are described. The stream of molten glass is divided into a number of thin streams under the effect of steam and rubbing when they contact each other. Due to the fact that glass does not harden immediately but in a definite temperature interval, these thin streams are drawn into very thin threads. The chief factors affecting the process of formation of glass threads are (1) pressure of superheated steam, (2) viscosity of the glass, (3) diameter of the glass stream which depends on the temperature of the glass, and (4) diameter of the aperture through which it flows. M.V.C.

Microscopical examination and identification of crystalline products in commercial glasses: II. A. J. HOLLAND AND ERIC PRESTON. *Jour. Soc. Glass Tech.*, **22** [90] 82–98 (1938).—Photographs obtained from microsections of crystalline inclusions in commercial glassware are given, showing the appearance of different devitrification products, refractory stones, and the disintegration of refractories by glass attack. The crystalline products discussed are quartz, cristobalite, tridymite, α- and β-wollastonite, devitrite, diopside, sillimanite, nephelite, mullite, and corundum. The great value of confirmatory evidence, such as that afforded by X-ray examination, is stressed in relation to the occurrence of diopside (magnesium calcium silicate) in certain bottle glasses. For Part I see *Ceram. Abs.*, **17** [9] 304 (1938). G.R.S.

Molecular volumes of glasses. O. KNAPP. *Keram. Rundschau*, **46** [21] 231–34 (1938).—The volumes computed according to the Biltz hypothesis and those observed show differences up to 4.87%. The hypothesis is erroneous. F.E.V.

Nontransparent glass. G. SCHIEB. *Deut. Glaserztg.*, **48**, 232–33 (1937).—S. describes the use of Polaroid glasses for reducing glare from automobile headlamps. E.P.

Oxidation and reduction equilibria in colored glasses. C. KÜHL, H. RUDOW, AND W. WEYL. *Sprechsaal*, **71** [7] 91–93; [8] 104–106; [9] 117–18 (1938).—The oxidation and reduction equilibria were studied by displacing absorption spectra. Equilibria were affected by conditions of melting, composition of the basic glass, and addition of oxidizing and reducing materials. The series studied are as follows: (1) iron-manganese glasses, (2) iron-cerium glasses, (3) iron-arsenic glasses, (4) iron-antimony glasses, (5) manganese-cerium glasses, (6) manganese-arsenic glasses, (7) manganese-antimony glasses, and (8) manganese-chrome glasses. The following oxidation series arranged in order of decreasing decomposition, *i.e.*, increasing resistance of higher oxides, resulted: CrO_3-Cr_2O_3, Mn_2O_3-MnO, CeO_2-Ce_2O_3, As_2O_5-As_2O_3, Sb_2O_5-Sb_2O_3, and Fe_2O_3-FeO. Mn_2O_3, for instance, acts as an oxidizing agent with relation to iron or arsenic equilibria; arsenic, however, acts as oxidizing agent for iron and as reducer for manganese. M.V.C.

Physicochemical properties of annealed glass in dependence on the conditions of air annealing. L. A. GEZBURG AND I. V. BOROVIKOV. *Ukrain. Khem. Zhur.*, **13**, 47–54 (1938).—Glass of special properties is better obtained by annealing by ventilator cooling than by annealing by natural cooling. The mechanical, tensile, bending, and impact strengths and vibration of cold-annealed glass are higher than those of heat-annealed glass. The crushing strength is lower. The chemical stability is practically equal for both methods. The resistance to spalling is 15 to 40% higher depending on the thickness of the glass. An especially high value is shown for impact strength. P.B. & E.S.

Polaroid glass, invisible cloak of glasses. O. H. *Deut. Glaserztg.*, **49**, 213–14 (1938).—H. describes the properties of Polaroid glasses. E.P.

Refractive-index measurements of some early American glasses. GEORGE T. FAUST. *Antiques*, **32** [6] 310–12 (1937).—Refractive-index measurements were made on 20 authentic specimens of Stiegel glass from the Metropolitan Museum collection, 3 South Jersey glasses, and 28 fragments of Wistarberg glass unearthed at the factory site. As anticipated, no correlation based on refractive index could be found. The values vary from 1.503 to 1.581. G.T.FAUST

Silvering of glass: I, Deposition of silver under various conditions. SEIKICHI MIYAGI AND TOSHIO INAGAKI. *Jour. Soc. Chem. Ind. Japan*, **41** [3] 67–68B (1938).—Tests showed that the deposition of silver on glass increases with time and temperature until saturation. The saturation value decreases with temperature, and when the temperature is raised, only a small fraction of the total amount of silver contained in the solution deposits as mirror. When the quantity of silvering solution is sufficiently great, the deposition is proportional to the surface area of the glass; the greater the relative surface of the glass, the higher is the efficiency of deposition. Silvering on a fresh glass surface is more effective than silvering on a surface once silvered. M.V.C.

Soda used in glassmaking. FIRMIN FALLEUR. *Verre & Silicates Ind.*, **9** [27] 318–19 (1938).—NaCl is not used in the glass batch except as a refining agent in determined amounts. Na_2SO_4 is also used for refining. In trying a new recipe, unsatisfactory results occur, probably because the formula is incomplete and must be corrected by study. Synthetic soda is extensively used in most glass industries. M.V.C.

Testing the characteristics of laboratory glassware and a few forms suited to microchemistry. W. GEFFCKEN AND P. H. PRAUSNITZ. *Oesterr. Chem.-Ztg.*, **40**, 426–32 (1937); *Chem. Abs.*, **32**, 393 (1938).—Studies of the attack of various reagents on glass are reviewed. Further results of an optical method for determining the extent of attack are given in four graphs. Since Cr^{+++} is strongly adsorbed by the protective gel layer which forms on glass surfaces, danger of contamination by subsequent elution of Cr is particularly important in biochemical work where an ordinary cleaning mixture is used. In place of CrO_3, H_2O_2, $NaNO_3$, or $NaClO_4$ is recommended as they are not adsorbed. For microchemical apparatus, Geräte glass 20, Duran glass, and Supremax glass have proved satisfactory. 20 references.

Twenty-one years; a professor looks out on the glass industry. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **22** [90] 99–164 (1938). G.R.S.

200-inch telescope. C. S. MCDOWELL. *Sci. Amer.*, **159**, 68–71 (1938).—A progress report on the work done is given. The dome of the observatory has been finished. The telescope tube is nearing completion, although there are still two years of work finishing the mirror and assembling the telescope. Several sketches give details of its design. W.D.F.

Use of the polishing of glass to characterize its chemical stability. B. N. MOSKVIN. *Optiko-Mekh. Prom.*, **7** [6] 5–6 (1937); abstracted in *Chem. Zentr.*, **1938, II**, 1293.—As glass polishing is essentially a chemical process, M. suggests a rapid and simple polishing method to determine and characterize chemical stability. M.V.C.

Viscosity of the soda-silica glasses at high temperatures and its bearing on their constitution. ERIC PRESTON. *Jour. Soc. Glass Tech.*, **22** [90] 45–81 (1938).—The viscosities from 800° to 1500° of 28 pure soda-silica glasses ranging in composition from 15.19 to 50.04% Na_2O were determined in a rotating concentric cylinder apparatus employing platinum cylinders to eliminate errors due to contamination by the containing vessels. A calibration method was avoided by calculating the viscosity from the known dimensions of the cylinders. Particular attention was paid to the attainment of temperature equilibrium before each test. The results are given in tables and in the form of viscosity-temperature and viscosity-composition curves. Strong evidence was found of the existence of a minimum in the viscosity-composition curves at a composition corresponding to the compound $Na_2O \cdot 2SiO_2$. A second minimum, less pronounced than the first, also occurred at $Na_2O \cdot 3SiO_2$. These minima were more pronounced at higher temperatures and were gradually eliminated as the temperature approached the liquidus temperature. The viscosity-composition curves are explained on the theory that molten glasses are liquids associated to a degree depending on temperature and composition and that the well-defined crystalline compounds characterized by the equilibrium diagram have continued existence in the liquid state. Work on the volatilization of Na_2O from soda-silica glasses is reviewed in the light of this new knowledge, which now permits a more logical explanation of the relationship between volatilization of alkali and chemical composition of the glasses. G.R.S.

Warming in of selenium-iron glasses and its significance in decolorizing with selenium. W. HÖFLER AND A. DIETZEL. *Glastech. Ber.*, **14** [11] 411–21 (1936).—A series of glasses with systematically varied selenium and iron oxide contents was prepared under neutral and strongly oxidizing conditions. Color changes with heat treatment were followed colorimetrically. The formation of FeSe according to the following equilibrium determines the conditions of warming in: $FeO + Na_2Se \rightleftarrows FeSe + Na_2O$. Lower temperatures favor the formation of FeSe. The equilibrium is attained rapidly over 600°C, becoming progressively slower at lower temperatures. Oxidizing melts tend to develop color in the annealing oven. Essentially neutral melts, however, develop color during working to the extent that no further change takes place on annealing. Transmission measurements show high transmission in the red with increasing absorption through yellow to blue. Transmission curves show that, in reducing melts with excess FeO, selenium is present largely as FeSe. In oxidizing melts, however, both Se and FeSe are present. Reducing melts are much more difficult to decolorize than oxidizing melts. In neither case does neutral gray result; it is more easily attained by the use of cobalt oxide. The most favorable melting conditions for decolorizing with selenium are mildly oxidizing. Numerous melts were exposed to daylight for 6 months. Only glasses containing FeO and As_2O_3 showed any noticeable color change. J.F.H.

PATENTS

Apparatus for:

Bending glass. D. H. GOODWILLIE (Libbey-Owens-Ford Glass Co.). U. S. 2,131,873, Oct. 4, 1938 (July 5, 1934).

Casehardening glass. WILLIAM OWEN (Pittsburgh Plate Glass Co.). U. S. 2,134,797, Nov. 1, 1938 (March 12, 1932).

Drawing tubes of glasses, *e.g.*, quartz, of high silica content. GENERAL ELECTRIC CO., LTD. Brit. 490,503, Aug. 31, 1938 (March 12, 1937).

Feeding molten glass. T. F. PEARSON (Crown Cork & Seal Co., Inc.). U. S. 2,134,732, Nov. 1, 1938 (April 17, 1935).

Forming glass articles. OWENS-ILLINOIS GLASS CO. Brit. 493,894, Oct. 26, 1938 (April 16, 1937).

Grinding and polishing strips of glass. PILKINGTON BROS., LTD., F. B. WALDRON, AND J. H. GRIFFIN. Brit. 491,851, Sept. 21, 1938 (March 9, 1937). F. B. WALDRON AND J. H. GRIFFIN (Pilkington Bros., Ltd.). U. S. 2,130,-255, Sept. 13, 1938 (Feb. 9, 1938).

Handling molten glass. W. W. TRIGGS (V. R. Cornelius). Brit. 491,846, Sept. 21, 1938 (March 3, 1937).

Making glass fiber mats. A. L. FORSTER (Owens-Illinois Glass Co.). U. S. 2,135,072, Nov. 1, 1938 (Oct. 20, 1937).

Producing ground or polished glass strip. PILKINGTON BROS., LTD., F. B. WALDRON, P. M. HOGG, AND G. H. BAILLIE. Brit. 492,288, Sept. 28, 1938 (March 17, 1937).

Applying a lubricant coating to glassware. R. C. WILLIAMS AND H. M. BONE (Ironsides Co.). U. S. 2,132,138, Oct. 4, 1938 (Jan. 17, 1935).

Blowing mineral wool. F. C. THOMAS (Standard Lime and Stone Co.). U. S. 2,136,158, Nov. 8, 1938 (Feb. 2, 1937).

Bottle. R. A. PATTERSON (Carr-Lowrey Glass Co.). U. S. 2,135,239, Nov. 1, 1938 (Sept. 3, 1936).

Bottle and glassware manufacture. THOMAS F. PEARSON (Crown Cork & Seal Co., Inc.). Can. 376,422, Sept. 13, 1938 (Jan. 28, 1937). G.M.H.

Bottle or glassware transferring apparatus. THOMAS F. PEARSON (Crown Cork & Seal Co., Inc.). Can. 376,-577, Sept. 20, 1938 (Feb. 5, 1937). G.M.H.

Combined asbestos and glass fiber yarn. D. C. SIMPSON (Owens-Illinois Glass Co.). U. S. 2,132,702, Oct. 11, 1938 (May 22, 1937).

Cover glass. S. L. LEBBY (Corning Glass Works). U. S. 2,133,664, Oct. 18, 1938 (Feb. 4, 1935).

Device for forming necks of bottles. SPESSARTER HOHLGLASWERKE, G.M.B.H. Ger. 663,040, June 30, 1938 (Sept. 19, 1936); VI/32*a*. 26. Hand- or machine-operated shears are employed in shaping the necks of bottles. D.A.B.

Device for making threads on exterior of glass containers. OTTO TRAUGOTT KARL SCHMIDT. Ger. 661,859, June 2, 1938 (May 15, 1936); VI/32*a*. 26. A spreading tool is introduced into the neck opening of the container. D.A.B.

Device for suspending glass sheets. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Ger. 661,627, May 25, 1938 (March 23, 1936); VI/32*a*. 30. A device is described for suspending glass sheets for the purpose of rewarming before the annealing process. A frame is provided with attachments for securing the glass sheet to the frame on all sides. The frame, with a number of members corresponding to the number of sides of the glass sheets, is fixed to the suspending apparatus proper in such a manner that the members of the frame can be separated from the rims or edges of the suspended sheet of glass. D.A.B.

Device for tempering sheets of glass, steel, etc., by air. LEONARDO MOSMIERI AND GINO DAL PINO (American Securit Co.). U. S. 2,131,406, Sept. 27, 1938 (July 30, 1932; renewed July 18, 1938).

Diffusing glasses. H. H. BLAU (Corning Glass Works). U. S. 2,132,390, Oct. 11, 1938 (July 3, 1935). A method of manufacturing a diffusing glass article having controlled light-modifying characteristics and internally uniform diffusing properties comprises forming the article in its entirety from a thermally opacifiable chemically homogeneous glass the composition of which is such that the light-diffusing inclusions form and grow in separated temperature ranges, causing the formation of a controlled number of inclusion-forming nuclei uniformly distributed throughout the article, and reheating the entire article uniformly to a temperature and for a time to cause the nuclei to grow to definite and controlled dimensions, and thereby controlling the number and size of diffusing inclusions and causing the article to have throughout uniform internal diffusing properties and controlled, definite, and predetermined light-modifying characteristics.

Disk-shaped grinding tool for sheet glass. PILKINGTON BROS., LTD. Ger. 659,172, March 31, 1938 (Feb. 4, 1935); XII/67*a*. 15. A rotating grinding tool for glass has the abrasive fed from the middle of the disk to the outer edges of the disk by means of grooves which run in a direction oblique to the circumference of the grinding tool. The surfaces of contact formed by the grooves are arranged in such a manner that they form angles, becoming larger toward the outer edge of the disk, of 45 to 90° with the radius, and the outer ends do not come behind the inner ends of the corresponding surface. The parts are arranged so that the rotating tool has the least resistance when in motion. D.A.B.

Dropping bottle with a pouring lip arranged on the rim of the neck. ALEXANDER GUSINDE. Ger. 661,623, May 25, 1938 (June 6, 1935); IX/30*g*. 1. A rib running the longitudinal direction of the neck of the flask is arranged on the inner wall of the neck and extends into the lip arranged on the rim. D.A.B.

Electric illuminating tubes with alkali-metal vapor atmosphere. RUDOLF SCHMIDT AND WALTER HÄNLEIN (Patent-Treuhand-Ges. für elektrische Glühlampen m. b. H.). Ger. 663,118, July 7, 1938 (Feb. 18, 1937); VI/32*b*. 1; addition to Ger. 513,306. Electric-light tubes with an alkali-vapor atmosphere, especially sodium vapor, have a tubular vessel lined with borosilicate glass. The borosilicate-glass liner has 4 to 9% SiO_2, 30 to 40% earth alkali, and 6 to 10% alkali to the boric acid content of 20 to 30% and the alumina content of 20 to 30%. D.A.B.

Electrical insulation. F. J. BAIRD AND A. L. SIMISON (Owens-Illinois Glass Co). U. S. 2,133,183, Oct. 11, 1938 (Aug. 22, 1933; renewed Aug. 13, 1936). An insulating material in sheet form comprises a body of matted glass wool, a binder of electrically nonconducting material impregnating the body, and a thin sheet layer of impervious insulating material covering the body.

Equipment for producing sheet glass. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Ger. 661,816, June 2, 1938 (May 22, 1936); VI/32*a*. 19. A rolling mill and annealing furnace are arranged so as to move to the front of the melting furnace. Several tank furnaces are arranged with the front lying in a straight line, and a unit consisting of a rolling mill and an annealing furnace is capable of being moved to the front of each individual tank furnace. D.A.B.

Feeder and method of feeding molten glass. F. L. O. WADSWORTH (Ball Bros. Co.). U. S. 2,130,702, Sept. 20, 1938 (March 18, 1933; renewed May 29, 1937).

Fusing tungsten wire into quartz by means of intermediate glasses. PHILIPS PATENTVERWALTUNG G.M.B.H. Ger. 663,337, July 7, 1938 (Oct. 17, 1934); VI/32*b*. 10. As a fusible glass for the tungsten wire, an alkali-free intermediate glass or one containing less than 1% alkali oxide is used. Glass should have a coefficient of expansion between 10 and 40 $\times 10^{-7}$. D.A.B.

Glass apparatus for chemical laboratories. WILHELM JUFFA. U. S. 2,133,705, Oct. 18, 1938 (Dec. 1, 1936).

Glass block closure. H. I. FOGELBERG. U. S. 2,129,-921, Sept. 13, 1938 (Aug. 5, 1937).

Glass blocks. F. A. CLEMO (Owens-Illinois Glass Co.). Brit. 491,906 and 491,907, Sept. 21, 1938 (Sept. 9, 1937).

Glass body shaping apparatus. HERMAN V. KIMBLE AND HARRY RICHTER (Kimble Glass Co.). Can. 376,089, Aug. 30, 1938 (Jan. 2, 1936). G.M.H.

Glass building material, especially for producing walls. CORNING GLASS WORKS. Ger. 663,271, July 7, 1938 (April 16, 1935); V/37*b*. 1.03. At least two opposite tiers or layers of glass building material are covered with an artificial resin, polyvinyl acetate, for joining the glass intimately and compensating the irregularities of the upper surfaces. This is brought about in such a manner that the outer surfaces of the resin layers are arranged in a position determined beforehand. D.A.B.

Glass composition. WALTER HÄNLEIN AND HERMANN KREFFT (General Electric Co.). U. S. 2,135,663, Nov. 8, 1938 (June 27, 1936; Jan. 25, 1937). A glass has the following composition: SiO_2 35, B_2O_3 10, Al_2O_3 30, CaO 15, and BaO 10%.

Glass electric-light bulb. LYLE E. CALKINS AND ORMONDE S. LEVI (Save Electric Corp.). Can. 376,940, Oct. 4, 1938 (Jan. 31, 1938). G.M.H.

Glass fabric. GAMES SLAYTER AND J. H. THOMAS (Owens-Illinois Glass Co.). U. S. 2,133,238, Oct. 11, 1938 (June 22, 1937).

Glass-feeding machine. HORACE A. ROBSON (Crown Cork & Seal Co., Inc.). Can. 376,423, Sept. 13, 1938 (Jan. 28, 1937). G.M.H.

Glass filter. W. O. LUERTZING (Ace Glass, Inc.). U. S. 2,136,170, Nov. 8, 1938 (Dec. 15, 1936).

Glass grinding apparatus. F. B. WALDRON (Pilkington Bros., Ltd.). U. S. 2,131,862, Oct. 4, 1938 (Jan. 28, 1938).

Glassmelting furnace. H. T. BRINK (Corning Glass Works). U. S. 2,133,654, Oct. 18, 1938 (Oct. 19, 1936).

Glass-to-metal seal. HOWARD SCOTT (Canadian Westinghouse Co., Ltd.). Can. 376,564, Sept. 20, 1938 (Aug. 7, 1936). G.M.H.

Glass stopcock. ERNST SCHULZ. Ger. 656,900, Feb. 3, 1938 (May 31, 1934); IX/42*l*. 13.01. Liquids are conveyed through the stopcock by means of grooves which lie in parallel planes perpendicular to the symmetrical axis of the stopcock plug and which are of equal width and depth but of unequal length. D.A.B.

Glass suction feeder. UNITED GLASS BOTTLE MANUFACTURERS, LTD. Ger. 663,117, July 7, 1938 (Feb. 3, 1936); VI/32*a*. 6. A glass suction feeder is provided with two suction cups being engaged alternately in the gathering and discharging position. The suction feeder is arranged between two forehearths in such a manner that, alternately, a gathering cup is dipped into the molten glass of its neighboring hearth while the other cup moves into the discharge position. D.A.B.

Glass tank furnace. H. J. BIVORT. U. S. 2,131,215, Sept. 27, 1938 (March 20, 1936).

Glassware forming machine. THOMAS F. PEARSON (Crown Cork & Seal Co., Inc.). Can. 375,956, Aug. 23, 1938 (Jan. 14, 1937). Can. 376,421, Sept. 13, 1938 (Jan. 14, 1937). G.M.H.

Glass wool and method and apparatus for making. GAMES SLAYTER AND J. H. THOMAS (Owens-Illinois Glass Co.). U. S. 2,133,236, Oct. 11, 1938 (Dec. 26, 1933).

Glassworking press. L. F. GOODRICH (Corning Glass Works). U. S. 2,133,767, Oct. 18, 1938 (March 16, 1936).

Graph for locating the optical center of a multifocal lens. SCOTT STERLING (Bausch & Lomb Optical Co.). U. S. 2,133,589, Oct. 18, 1938 (April 24, 1937).

Heat insulation. J. H. PLUMMER (Owens-Illinois Glass Co.). U. S. 2,134,340, Oct. 25, 1938 (Oct. 3, 1935; renewed April 1, 1938).

Hollow glass blocks. OWENS-ILLINOIS GLASS CO. Brit. 494,052, Nov. 2, 1938 (April 16, 1937).

Hollow glass building block. F. A. CLEMO (Owens-Illinois Glass Co.). Brit. 492,419, Oct. 5, 1938 (Sept. 9, 1937).

Hydrodynamic balance feeder and method of feeding molten glass. F. L. O. WADSWORTH (Ball Bros. Co.). U. S. 2,131,242, Sept. 27, 1938 (Feb. 11, 1933; July 19, 1935).

Increasing resistance of glass to alkali-metal vapors. CORNING GLASS WORKS. Ger. 661,817, June 2, 1938 (Nov. 4, 1935); VI/32*b*. 6.50. A solution of salts is put on the glass; the salts are transformed into a thin, virtually transparent layer upon subsequent firing on at about 600°C. The solution consists of boric acid or an alkali compound or a mixture of these substances. D.A.B.

Insulator. J. C. HOSTETTER AND J. T. LITTLETON (Corning Glass Works). U. S. 2,133,768, Oct. 18, 1938 (Sept. 7, 1937).

Interchangeable protectors for walls of furnaces for melting glass. VEREIN DEUTSCHER TAFELGLASHÜTTEN G.B.M.H. Ger. 663,352, July 7, 1938 (April 23, 1936); VI/32*a*. 5. The side of the protector toward the melt is adjusted to the course of flow of the melt. D.A.B.

Laminated glass. W. O. HERRMANN (Chemische Forschungsges. m.b.H.). U. S. 2,135,075, Nov. 1, 1938 (May 13, 1936).

Lamp shade. J. A. KORENGOLD. U. S. 2,131,442, Sept. 27, 1938 (April 22, 1937).

Lens. ARTHUR WARMISHAM (Kapella, Ltd.). U. S. 2,130,760, Sept. 20, 1938 (May 5, 1937).

Lens system. CHARLES W. FREDERICK AND WILY SCHADE (Canadian Kodak Co., Ltd.). Can. 376,063, Aug. 30, 1938 (Dec. 11, 1937; in U. S., May 22, 1937). G.M.H.

Low-temperature insulation. GAMES SLAYTER (Owens-Illinois Glass Co.). U. S. 2,134,009, Oct. 25, 1938 (Sept. 25, 1935).

Machine for manufacturing blown glass articles of great capacity. EMILE ROIRANT (Soc. Anon. d'Études et de Constructions d'Appareils Mécaniques pour la Verrerie). U. S. 2,134,342, Oct. 25, 1938 (Jan. 2, 1936).

Manufacture of compound glass and other laminated materials. A. ROSENTHAL. Brit. 490,771, Aug. 31, 1938 (March 2, 1937).

Manufacture of curved glasses with edge bent around for hanging. ADOLF BAHRIG. Ger. 661,704, June 2, 1938 (April 3, 1937); VI/32*a*. 27. Glass to be used for illuminating purposes is provided with a hanging edge by doubling back the free ends of curved glass articles (produced by molding a sheet of glass) inward while the glass is still in the plastic stage. D.A.B.

Manufacture of fabric from spun glass. H. F. C. CORDTS (Thüringische Glaswollindustrie vorm. S. Koch Ges.). U. S. 2,131,024, Sept. 27, 1938 (Oct. 16, 1935).

Manufacture of glass sheets, particularly their continuous manufacture by means of rotating devices or rollers exposed to heat. SOC. ANON. DES MANUFACTURES DES GLACES & PRODUITS CHIMIQUES DE ST. GOBAIN, CHAUNY & CIREY. Brit. 493,004, Oct. 12, 1938 (July 16, 1936).

Manufacture of mineral wool. A. T. SHRUM (W. C. Coryell). U. S. 2,131,599, Sept. 27, 1938 (Aug. 6, 1934).

Manufacturing fluorescent glass. SOC. A. R. L. JEROME & BONNEFOY & CIE. Brit. 492,960, Oct. 12, 1938 (Jan. 30, 1936).

Means for producing multibore glass tubing. EDWARD DANNER. U. S. 2,131,417, Sept. 27, 1938 (July 29, 1936).

Method and apparatus for annealing glassware. HARTFORD-EMPIRE CO. Brit. 491,954, Sept. 28, 1938 (March 2, 1936).

Method and apparatus for annealing glassware. D. G. MERRILL (Hartford-Empire Co.). U. S. 2,133,783, Oct. 18, 1938 (Dec. 14, 1935). U. S. 2,133,784, Oct. 18, 1938 (Sept. 22, 1936).

Method and apparatus for banding or decorating articles. LIBBEY GLASS CO. Brit. 493,857, Oct. 26, 1938 (Feb. 2, 1937).

Method and apparatus for bending vitreous tubing. W. R. WALKER (General Electric Vapor Lamp Co.). U. S. 2,135,775, Nov. 8, 1938 (Oct. 12, 1934).

Method and apparatus for decorating articles. DAVID DENELSBECK (Owens-Illinois Glass Co.). U. S. 2,132,868, Oct. 11, 1938 (Nov. 17, 1933; renewed March 17, 1938).

Method and apparatus for decorating bottles, etc. CARROLL CONE (Owens-Illinois Glass Co.). U. S. 2,132,818, Oct. 11, 1938 (June 18, 1936; renewed March 1, 1938).

Method and apparatus for drawing glass. D. E. GRAY (Corning Glass Works). U. S. 2,133,662, Oct. 18, 1938 (April 10, 1936).

Method and apparatus for forming glass articles. Owens-Illinois Glass Co. Brit. 493,478, Oct. 19, 1938 (April 5, 1937).

Method and apparatus for producing hollow glass articles. L. Mellersh-Jackson (Owens-Illinois Glass Co.). Brit. 492,622, Oct. 5, 1938 (Aug. 24, 1937).

Method for union of metal and ceramic parts. Hans Pulfrich (Patent-Treuhand-Ges. für elektrische Glühlampen m.b.H.). Ger. 659,427, April 7, 1938 (Oct. 10, 1936); VI/80*b*. 23.01. A metallic powder with a high melting point such as tungsten or molybdenum is sintered on the ceramic article at a temperature which lies above the melting point of the lowest melting point of the eutectic and below the melting point of the ceramic article and the metal. The metallic and ceramic parts are joined together by means of a solder which forms no alloy with the sintered metal. D.A.B.

Multifocal lens manufacture. Dudley F. Taylor (Continental Optical Co., Inc.). Can. 375,778, Aug. 16, 1938 (Aug. 7, 1937). G.M.H.

Nonreflecting window. J. J. Hopfield (Libbey-Owens-Ford Glass Co.). U. S. 2,131,875, Oct. 4, 1938 (Dec. 31, 1935).

Ophthalmic lens. M. A. Laabs (American Optical Co.). U. S. 2,133,994, Oct. 25, 1938 (Aug. 22, 1935).

Plate glass surfacing table. William Owen (Pittsburgh Plate Glass Co.). U. S. 2,134,798, Nov. 1, 1938 (March 29, 1938).

Preparations for treating glass, etc., to maintain a clear surface. J. S. Banks. Brit. 494,113, Nov. 2, 1938 (April 26, 1937).

Press molds for molding glassware. D. K. Fairweather. Brit. 492,683, Oct. 5, 1938 (March 25, 1937).

Producing articles of cellular glass. Soc. Anon. des Manufactures des Glaces et Produits Chimiques de St. Gobain, Chauny & Cirey. Ger. 657,606, Feb. 24, 1938 (April 27, 1935); VI/32*b*. 1. Glass of desired composition is poured into a container; into the glass is immersed a mold in the shape of a bell whose inner sections are equipped with a device for diminishing pressure for molding the glass and for expanding gases in the glass. D.A.B.

Producing drop bottles. Carl Schnuerle. Ger. 658,752, March 24, 1938 (Nov. 6, 1933); VI/32*a*. 15. D.A.B.

Producing graduated plates. Askania-Werke, A.-G. (Centralwerkstatt Dessau) and Carl Bamberg-Friedenau. Ger. 662,741, June 23, 1938 (March 7, 1936); VI/32*b*. 10. A covering layer is applied to the glass surface and the marking is made in this layer. A metallic layer is applied to the glass which is provided with the layer which contains the marking, and the metallic layer adheres only at the marked places on the glass. This metallic layer is removed together with the original layer which covered the glass. D.A.B.

Producing a heat-absorbing borosilicate glass. Corning Glass Works. Ger. 658,992, March 24, 1938 (June 12,1930); 32*b*. 2; addition to Ger. 645,460 (June 1, 1937). Glass for obtaining daylight effects is compounded according to Ger. 645,460 and cobalt is added to the batch. The proportion of iron oxide to cobalt oxide is between 4 to 1 and 16 to 1. D.A.B.

Producing mirrors. Duro-Ray, Ltd. Ger. 657,519, Feb. 17, 1938 (Feb. 6, 1935); VI/32*b*. 10. The method provides for depositing a silver layer on the glass and then applying a metallic protective layer electrolytically. A layer consisting practically of pure colloidal silver is deposited on the glass, and directly over this layer a lead layer is deposited electrolytically by using an almost neutral electrolyte which is free of troublesome acidic or alkaline admixtures. D.A.B.

Producing multilayer shatterproof glass. Soc. Générale d'Optique, Soc. Anon. des Anciens Établissements Huet & Cie, and Jumelles Flammarion. Ger. 658,565, March 17, 1938 (Dec. 4, 1933); XII/39*a*. 17.50. A more or less viscous binding agent is caused to go between the glass panes which have a definite gap between them. The viscous liquid is forced into this gap by a difference of pressure and it is caused to flow between the sheets or panes of glass, arranged vertically, from the bottom to the top of the gap. D.A.B.

Producing multilayer shatterproof glass with imbedded wire. Glas- und Spiegelmanufaktur N. Kinon. Ger. 658,852, March 24, 1938 (Feb. 3, 1936); XII/39*a*. 17.50. Multilayer shatterproof glass with imbedded wire for electrical heating effects is produced by introducing wire into the elastic binding layer during the union of the glass panes by pressure. D.A.B.

Producing safety glass. Société des Usines Chimiques Rhône-Poulenc. Ger. 663,577, July 14, 1938 (Nov. 6, 1931); IV*c*/39*b*. 27. Two glass plates are joined by a layer of plastic material. Only the layer or film of plastic material is exposed to the action of a vacuum for a long time before the union of the glass plates. D.A.B.

Producing shatterproof compound glass. Imperial Chemical Industries, Ltd. Ger. 662,159, June 9, 1938 (Nov. 30, 1935); IV*c*/39*b*. 27. Plates of glass are joined together by a plastic layer containing nitrocellulose and a polymerized ester of acrylic acid. Ten parts of nitrocellulose, 2 to 5 parts of polymerized material, *e.g.*, methyl methacrylate (methyl 1-methylacrylate), and 10 parts of a suitable softening agent (for the nitrocellulose and the polymerized material) form the plastic transparent layer which is produced by pressing or rolling together the constituents and the volatile solvent until evaporation of the solvent is brought about by the hot rollers. D.A.B.

Production of laminated glass plates. B. E. Grossmann. Brit. 493,153, Oct. 19, 1938 (April 11, 1936).

Production of thin perforated sheets of glass or metal. B. Wempe. Brit. 490,690, Aug. 31, 1938 (Feb. 20, 1936).

Refractory bushing alloy liner. John H. Thomas and E. Fletcher (Owens-Illinois Glass Co.). Can. 375,813, Aug. 16, 1938 (March 5, 1937). G.M.H.

Refractory glasses. General Electric Co., Ltd., and J. H. Partridge. Brit. 493,803, Oct. 26, 1938 (July 19, 1937).

Sheet glass handling apparatus. C. D. Burrell (Libbey-Owens-Ford Glass Co.). U. S. 2,131,869, Oct. 4, 1938 (April 16, 1937).

Skimming device for glass tanks or furnaces. Thomas F. Pearson (Crown Cork & Seal Co., Inc.). U. S. 2,134,838, Nov. 1, 1938 (April 29, 1937).

Spun glass and method for producing. Lambert Jansen (A.-G. der Gerresheimer Glashüttenwerke vorm. Ferd. Heye). Ger. 663,006, June 30, 1938 (Nov. 17, 1936); VI/32*a*. 25. Spun glass to be used in subsequent manufacture of textile products is described. The surfaces of the glass fibers are roughened by the use of caustics. D.A.B.

Suction fed glassforming machine. Lynch Corp. Ger. 642,788, Feb. 25, 1937 (Jan. 30, 1932); VI/32*a*. 12; *Jour. Soc. Glass Tech.*, **21**, A265 (1937). The Lynch "10" operation is described.

Suction gatherer. T. F. Pearson (Crown Cork & Seal Co., Inc.). U. S. 2,134,733, Nov. 1, 1938 (April 17, 1935; renewed Oct. 20, 1937). U. S. 2,134,734, Nov. 1, 1938 (April 17, 1935).

Tempering glass articles. Pilkington Bros., Ltd. Ger. 662,790, June 23, 1938 (Jan. 11, 1936); VI/32*a*. 30. Glass articles consisting of ring-shaped zones of unequal wall strength are tempered by means of a gaseous or liquid cooling agent which is directed against the articles by the use of jets. The cooling of the thinner parts of the article is temporarily delayed until after the cooling of the thicker parts. D.A.B.

Tempering glass articles, especially glass plates. A.-G. für Glasindustrie vorm. F. Siemens. Ger. 663,430, July 14, 1938 (July 18, 1936); VI/32*a*. 30. The stationary glass articles fixed in a vertical position are heated up by successively shifting the heating and cooling apparatus toward the glass article and away from it; the article is then cooled. The glass articles clamped in a mobile device are tempered in a virtually vertical plane during the duration of treatment and are rotated. D.A.B.

Textile material. GAMES SLAYTER (Owens-Illinois Glass Co.). U. S. 2,133,237, Oct. 11, 1938 (Feb. 7, 1936; renewed May 4, 1938).

Transparent glass colors. J. H. YOUNG (E. I. du Pont de Nemours & Co.). U. S. 2,130,215, Sept. 13, 1938 (March 5, 1936; renewed July 27, 1938). A process for preparing a vitrifiable coloring composition which when applied to a glass object to be coated will result in a transparent color comprises melting together a pigment of the metallic sulfide type in an amount not exceeding about 5% by weight of the batch, a compound having the same metallic radical as the sulfide coloring pigment, and a suitable low-melting lead borosilicate glass base formed from a nonoxidizing lead compound, the melting being carried out under substantially neutral conditions, air being excluded from the vessel, and the time and temperature employed during the melting being carefully controlled so that a transparent product will result when the vitrifiable composition is fired in use.

Wall facing. FRANK SOHN (Libbey-Owens-Ford Glass Co.). U. S. 2,132,547, Oct. 11, 1938 (Aug. 21, 1935).

Structural Clay Products

Brick paving in Baltimore. F. K. DUNCAN. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 15–19; *Dependable Highways*, No. 159, pp. 3–8 (1938).—D. traces the history of brick paving in Baltimore streets from 1881 to the present time. Specifications and methods of construction followed in recent WPA projects are included. Illustrated. P.S.D.

Brick paving in East St. Louis relief programs. R. F. KOCH. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 21–24.—Following a brief discussion of the history of brick pavement in East St. Louis, K. discusses unit labor costs of recent WPA pavement projects in the city. The manner of old street railway removal and the treatment of old concrete base courses are described. Illustrated. P.S.D.

Brick paving in the relief program. A. G. WALTER. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 25–28; *Dependable Highways*, No. 159, pp. 9–11 (1938).—Data are given concerning recent WPA paving projects using vitrified paving brick, in Dunkirk, N. Y. P.S.D.

Brick, tile, and paving brick. R. LEDUC. *Argile*, No. 181, p. 15; No. 182, pp. 17–19; No. 183, pp. 19–21; No. 184, pp. 7–11; No. 185, pp. 7–9 (1938).—L. covers the knowledge a ceramist manufacturing brick and tile should possess. A general discussion of ceramic products is followed by a study of (1) clay raw materials and their classification and properties; (2) the plastic properties derived from the hydrated oxides of silicon, aluminum, and iron; (3) choice of quarries and the extraction of clays in France; (4) the choice of materials; (5) humidity, storing, and drying, and (6) preparation of clays in disk grinders, cylinders, and mixers. M.V.C.

Drainpipe. L. B. *Argile*, No. 178 (Jan.), pp. 17–19; No. 178 (Feb.), pp. 5–9; No. 179, pp. 5–9; No. 181, pp. 5–7; No. 182, pp. 5–7; No. 183, pp. 5–7; No. 184, pp. 5–7 (1938).—A rather fat clay with 22 to 25% water is required for the manufacture of drainpipe, and a modern helix machine is preferred for mixing. B. studies the operation of drawplates, cutting processes, and fixtures and gives practical suggestions and pointers for the manufacture of drainpipe in horizontal molding machines, where the maximum diameter can not exceed 12 to 14 cm., and for larger pipe where cylinder or helix vertical machines are used (the former being preferred). Practical advice on the problems connected with artificial drying and firing is presented. M.V.C.

Experiences with bedding courses and cement grout fillers. R. R. LITEHISER. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 7–13.—Illustrated. P.S.D.

Lincoln Tunnel pavement. E. W. BOWDEN. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 31–41; *Dependable Highways*, No. 158, pp. 3–11 (1938).—Criteria governing the selection of a suitable pavement material for the Lincoln Tunnel are reviewed and analyzed. The conclusions regarding (1) skidding characteristics, (2) wear resistance, (3) smooth riding qualities, (4) noiselessness, and (5) ultimate cost led to the selection of de-aired vitrified paving brick as the pavement material. Specifications for the pavement material are included. Illustrated. **Discussion.** J. A. WILLIAMSON. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 43–48; *Dependable Highways*, No. 158, pp. 12–15 (1938).—W. describes the construction details of the Lincoln Tunnel pavement including (1) bed course, (2) laying of pavers, (3) rolling, and (4) application of filler. P.S.D.

New life and more pavement. F. T. WILLIAMS. *Dependable Highways*, No. 160, pp. 3–5 (1938).—W. gives details concerning the re-laying of a 30-year old brick pavement at Sanford, Florida. A unit cost analysis is included. P.S.D.

Specifications and tests for paving brick. F. H. JACKSON. *Proc. Nat. Paving Brick Assn.*, **1938**, pp. 49–53.—J. gives an extended and critical discussion of the standard rattler test for paving brick from the time of its development until the present. Possible methods of modifying the rattler test to yield suitable information leading to the detection of the kind of brick which tend to develop surface defects are described. A comprehensive coöperative research program, to be conducted by the U. S. Bureau of Public Roads and the National Paving Brick Assn., includes (1) a critical study of samples of brick from several good and bad projects recently surveyed by the Bureau and (2) the construction and testing of an experimental road using brick of varying quality from different plants. It is hoped that the results of the study, tied in with laboratory investigation, will make it possible to determine the special tests that will identify the kind of brick giving rise to troublesome surface defects. P.S.D.

Weatherproof brickwork. Factors which control its design and construction. LEONARD W. BURRIDGE. *Brit. Clayworker*, **47** [555] 119–31 (1938).—Apart from its ingress as the result of failure of associated construction such as cracked rainwater heads, gulleys, faulty plumbing, unpainted window frames, etc., moisture in one form or another may enter construction by any of four ways: (1) *laterally*, in the form of (*a*) rain impinging on and absorbed by the exposed face or faces of the brickwork, and (*b*) ground water under its own hydrostatic head into brickwork walls of subground chambers, basements, and cellars; (2) *downward*, as the result of percolation of rain or melting snow into the top of a wall from badly designed or faulty roofs, parapet walls, sills, etc.; (3) *upward*, both in the form of ground water (*a*) drawn upward from the soil by capillary pull, augmented by the wick action of evaporation, which occurs, *e.g.*, in old garden walls containing no dampproof course, (*b*) under its own hydrostatic head into the floors and walls of subground construction which extend below the water plane, and (*c*) as rain, cleansing water, etc., splashing up from pavements or floors; (4) *ubiquitously*, in the form of condensation from highly humid air which, rising and coming in contact with cold walls, etc., deposits part of its moisture on their inner faces. Each mode of water penetration is discussed in detail, and recommendations are made to prevent or minimize it. R.A.H.

PATENTS

Apparatus for applying a surface finish to brick. HAMMILL BRICK CO., LTD., AND G. V. PARKER. Brit. 491,561, Sept. 14, 1938 (March 2, 1937).

Building block. ALBERT HENDERSON (W. P. Witherow). U. S. 2,131,803, Oct. 4, 1938 (May 15, 1936). A building block having top and bottom faces constituting mortar-receiving portions of the block and side and end faces, all generally at right angles to one another, at least one end face having a recessed panel whose margins are spaced

inwardly from all four edges of the face, but which panel extends over the major portion of the face, the other end face having a slot therein extending from the top face to the bottom face, whereby, when such blocks are disposed end to end in courses, the slot in one block and the recessed panel in the end of an adjacent block form keys with the mortar therebetween.

Manufacture of brick or blocks. E. CLARKE. Brit. 493,777, Oct. 26, 1938 (April 13, 1937).

Manufacturing heat-insulating material. WILHELM POLLE. Ger. 661,965, June 2, 1938 (June 16, 1936); VI/80*b*. 9.09. Material containing water glass is swollen up by heat treatment. A mixture of water glass and an alcoholic liquid is used as starting material. D.A.B.

Method and apparatus for tempering glass. BERNARD LONG (American Securit Co.). U. S. 2,131,404, Sept. 27, 1938 (April 8, 1936).

Producing a cellular clinker-like product by firing clay, rocks, or mixtures thereof, and a product thus produced. E. I. LINDMAN. Brit. 491,339, Sept. 14, 1938 (June 14, 1937).

Producing highly porous ceramic articles. PAUL GLANTZ AND HERMANN GLANTZ. Ger. 663,453, July 14, 1938 (May 18, 1934); VI/80*b*. 18.03. Highly porous ceramic articles are produced by casting and firing a mixture of brick clay and combustible and oxygen-generating admixtures. A material which decomposes into oxidizing and nonoxidizing gases and leaves no residue is employed as an admixture. D.A.B.

Producing porous articles by casting a pasty mass. CARBORUNDUM CO. Ger. 662,204, June 9, 1938 (Nov. 7, 1934); VI/80*b*. 18.02. A pasty or doughy mass, which contains a gas-producing material and a special agent for repressing the gas-producing material in its action of making the cast mass porous, is cast. The catalyst is removed from the primary constituents of the mass, and the mass is then mixed with the gas-producing material; the degree of gas formation in the mass is regulated by controlling the temperature. D.A.B.

Production of brick with wearproof layer or coating. J. RAMSAUER. Swiss 197,810, July 16, 1937; *Chem.-Ztg.*, **62** [70] 629 (1938). D.A.B.

Toy building block. N. I. PAULSON (Halsam Products Co.). U. S. 2,132,757, Oct. 11, 1938 (Oct. 8, 1936).

Wall construction. H. J. SCHUBERT. U. S. 2,134,894, Nov. 1, 1938 (March 29, 1937).

Refractories

Attack of refractories by wood ash. M. LÉPINGLE. *Compt. Rend. 17th Congr. Chim. Ind.*, **1937**, 141–65; *Brit. Chem. & Phys. Abs.-B*, **57** [7] 785 (1938).—The attack is due to alkali, and only 2 out of 16 commercial fire brick of the SiO_2-Al_2O_3 type resisted attack. Immunity appears to be due to closeness of texture and freedom from impurities and is correlated with the presence of organic matter naturally present in the materials of manufacture.

Behavior of refractory materials under torsion at different temperatures: III. A. L. ROBERTS AND J. W. COBB. *Trans. Ceram. Soc.*, **37** [7] 296–311 (1938); see *Ceram. Abs.*, **17** [5] 186 (1938). R.A.H.

Chemical analysis of refractory hard materials. G. A. KALL. *Oberflächentech.*, **15** [16] 159–62 (1938).—Silicon carbide which is used as a refractory material in industrial furnaces is made in two varieties, black and green; both contain impurities of SiO_2, Fe, Ti, Al, C, S, and earth alkalis. K. explains the lengthy and tedious exact analysis and describes a shorter method which is sufficiently correct for industrial routine purposes. M.H.

Chromium-magnesia refractory brick. D. CARABIN. *Jour. Four. Élec.*, **45**, 281–82 (1936); *Chem. Abs.*, **30**, 7803 (1936).—C. describes the new types of brick for Martin and basic electric steel furnaces. Trademarks are Kromag (U.S.A.), Saxpyre (English), and Radex E (Austrian). They are resistant to temperature changes and have high melting points. Kromag does not react with basic charges. Disadvantages are higher cost and density (3.00 compared with 2.35 for silica brick).

Course in glassmaking. Résumé. ANON. *Verre & Silicates Ind.*, **9** [12] 138–40 (1938).—The properties of siliceous refractory products used in the construction of glass furnaces are given. See *Ceram. Abs.*, **17** [3] 103 1938). M.V.C.

Economic production of pure alumina from clay and similar substances by the alkaline process. W. GUERTLER. *Z. Elektrochem.*, **43** [8] 501–502 (1937).—The production of pure alumina from clay by the alkaline extraction method, with precipitation of the silica as Ca_2SiO_4, has been rendered economical by the Cowles process for the production of cement from Ca_2SiO_4 mud by heating with an additional mole of $CaCO_3$. E.J.V.

Enrichment of inferior bauxite. V. CHARRIN. *Argile*, No. 185, pp. 1–5 (1938).—To improve the composition of a bauxite it is necessary to determine the extremely complex and variable combination of aluminum oxides, oxysilicates, silicates, and ferric and titanium oxides. Either iron or silica may be the harmful element for industrial use and, while methods for the removal of iron have been satisfactory, it has been shown that by reducing the iron content in a mineral in which silica is the harmful ingredient, this mineral can be utilized. Red bauxite No. 1 with at least 50% alumina is used for the production of aluminum. Red bauxite No. 2 is used for aluminous cements and for colors. White bauxites Nos. 1 and 2 are used in ceramics and for the manufacture of abrasives. Refractory or siliceous bauxites are used for refractories. M.V.C.

Gas-tight sintered alumina ware. VAUGHAN H. STOTT. *Trans. Ceram. Soc.*, **37** [8] 346–54 (1938).—The preparation and properties of sintered alumina ware are outlined, and technical details of its preparation are given. S. points out that sintering, which is a process of crystal growth, takes place in oxides other than alumina and may in the future be utilized for the production of large crystals of refractory oxides. R.A.H.

Graphite in the metal industry: crucibles and facing materials. H. N. BASSETT. *Metal Ind.* [London], **51** [4] 87–88 (1937). H.E.S.

Heat insulators in industry. A AUBERT. *Usine*, **45** [14] 31–33 (1936); *Chem. Abs.*, **30**, 5324 (1936).—A. discusses advantages, application, and methods of examining heat-insulating materials such as powders, brick, or envelopes and gives the heat conduction of the following materials: organic (straw, cotton, wood, felt), mineral (kieselguhr, $MgCO_3$, mica), and textiles of silk, glass, or slags. The method of calculating the required heat insulation for given conditions is briefly described. See "Thermal—," *Ceram. Abs.*, **17** [8] 281 (1938).

Improving the quality of fire brick. ANON. *Brit. Clayworker*, **47** [557] 195–96 (1938).—Among the many improvements which have been made in the technical developments of the firebrick industry are a greater selection in the fire clay used, better grinding and more suitable combinations of grain sizes, undesirability of the wire-cut process in manufacture, control of water content and dust proportion, and proper particle packing through elimination of entrapped air. R.A.H.

Manufacture of grog brick fired at low temperature. E. K. KÖHLER. *Zitein-Tech. So.*, Series 27, No. 86, 9 pp. (1937); abstracted in *Referat. Silikatliteratur*, **5** [4] 5156 (1938).—Grog brick fired at low temperatures, 400° to 800°C, have a higher resistance to pressure when cold, are more resistant to slag attack, and have a lower porosity. The plastic-shaping and the dry-shaping methods may be used in their production. The chief characteristics of these brick are given in a table. M.V.C.

Open-hearth practice in the steel foundry. J. W. PORTER. *Steel*, **101** [23] 46–48, 50 (1937).—P. describes and illustrates the general procedure and operation of a modern open-hearth plant. H.E.S.

Possible new silica products. HAROLD SHAW. *Blast*

Furnace & Steel Plant, **24** [8] 721–22 (1936).—S. suggests the possibility of a highly refractory brick of lower specific gravity than that of silica made from a mixture of diatomaceous earth and silica rock. A properly proportioned mixture should, theoretically, produce a brick light in nature, highly refractory, and having insulating properties. Low porosity silica brick (12 to 16% instead of 25% standard) have better resistance to corrosion, erosion, and gas impingement. Addition to the brick batch of about 2½% finely ground basic open-hearth slag, powdered charcoal, and 2% milk of lime produces a silica brick, chocolate in color, of approximately 93.68 SiO_2, 0.19 Al_2O_3, 2.31 Fe_2O_3, 3.21 CaO, 0.25 MgO, and 0.38% MnO, with wearing properties superior to those of ordinary silica brick. Double firing to reduce afterexpansion in service is also discussed. E.J.V.

Preparation of pure alumina from Manchurian aluminous shale: I, Treatment of Fukushu aluminous shale with sulfuric acid. Tsuyoshi Arimori. *Jour. Soc. Chem. Ind. Japan*, **40** [7] 270–71B (1937).—Fukushu aluminous shale is a superior refractory material in Manchuria and contains 45 to 70% aluminum and a high silica content. A. concludes that (1) when the fired ore is treated with sulfuric acid at 99°C, only 19.65% of the alumina is extracted, probably because only the alumina in the form of kaolinite dissolves; (2) when the fired ore is treated with sulfuric acid under pressure, a maximum of 98.57% alumina is extracted; (3) optimum conditions for extraction are as follows: (*a*) the ore must be crushed to 100-mesh sieve fineness and calcined at 600°C, (*b*) the sulfuric acid concentration should be 50° Bé, (*c*) the amount of sulfuric acid must be the chemical equivalent of the percentage of bases, and (*d*) temperature of extraction must be 180°C for 4 hr. **II, Treatment of Fukushu aluminous shale with a mixture of sulfuric acid and ammonium sulfate under pressure.** *Ibid.*, [11] 411–12B.—The best composition of the acidic mixture is 4 mol. sulfuric acid and 1 mol. ammonium sulfate per 1 mol. alumina in the ore. The concentration of acid should be 50° Bé; the temperature of extraction is 180°C. The percentage of extraction of alumina when the acidic mixture is employed is somewhat higher than that when sulfuric acid only is used, but this difference is not considered sufficiently important to warrant the adoption of the acidic mixture process for the extraction of alumina from Fukushu aluminous shale. The single acid process (using sulfuric acid only) is simple and has several advantages in later treatment. **III, Treatment of Fukushu aluminous shale with the Bayer and lime-soda processes.** *Ibid.*, **41** [2] 34–35B (1938).—The alumina existing in the form of diaspore, the chief constituent of this ore, is dissolved to some extent by the Bayer process and the lime-soda process. The loss of soda is comparatively small in the lime-soda process in spite of the poor percentage of alumina extracted; the improvement of this process constitutes an important problem. **IV, Treatment of Chinchou aluminous shale with sulfuric acid.** *Ibid.*, [4] 104–105B (1938).—Chinchou aluminous shales are classified as high aluminous raw materials consisting of diaspore and kaolinite with more than 45% alumina and relatively poor aluminous raw materials consisting of kaolinite with about 40% alumina. Optimum conditions for extracting alumina with sulfuric acid are as follows: (1) the ore must be crushed to 100-mesh fineness and calcined at 600° to 700°C for 4 or 5 hr.; (2) the amount of sulfuric acid used must be chemically equivalent to the percentage of bases in the ore; and (3) the concentration of sulfuric acid should be 40° Bé. The extraction must be performed while the sulfuric acid is boiling. M.V.C.

Relative thermal expansion coefficients of shell, brick, coating, and lining of a cement rotary kiln: III. T. Yoshii. *Jour. Soc. Chem. Ind. Japan*, **40** [10] 352–53B (1937).—Y. measured the coefficient of thermal expansion of kiln shell, brick, and coating; the coefficient of the shell is largest, while that of the brick is the smallest. Unfavorable stress is caused between shell, brick, and coating because of temperature fluctuations in the kiln and the difference in thermal expansion of each, loosening the coating and thus shortening the brick life. This may be prevented to some extent by adjusting the thermal expansion coefficient of the brick to lie between that of the shell and that of the coating and by adapting their thickness accordingly. For Part I see *Ceram. Abs.*, **16** [11] 341 (1937). M.V.C.

Results obtained with chrome-magnesite brick in open-hearth steel furnaces. A. E. Dodd. *Trans. Ceram. Soc.*, **37** [8] 339–45 (1938); see *Ceram. Abs.*, **17** [5] 188 (1938). R.A.H.

Selection of refractories. B. Thomas. *Iron & Coal Trades Rev.*, **138** [3684] 537–38 (1938).—T. discusses factors in selecting a refractory on the basis of three typical operations. Low-temperature furnaces for billet heating, light forgings, etc., from 900° to 1200°C, use a Stourbridge brick advantageously. These furnaces are fired either mechanically or manually with solid fuel. High-temperature furnaces for 1750° to 1770°C are heated only automatically with pulverized fuel or mechanically stoked solid fuel. The third group comprises steel-heating furnaces for temperatures up to 1450°C, in which a predominant danger of slagging exists; a brick with a spinel base is preferable. The points to be observed in connection with the kind of fuel used are discussed, and the purpose of insulating brick in metallurgical furnaces is explained. Heat-insulating materials are described; the materials chiefly used for insulation are diatomite and diatomaceous silica, with a melting point of 1590°C. The preparation of mixtures and the building of furnace walls are described. M.H.

Setting new standards for blast-furnace runs. G. G. Coolidge. *Blast Furnace & Steel Plant*, **25** [5] 493–95 (1937).—C. cites the improvement of blast-furnace run records from 1895, when 70,000 gross tons was high, to the present when a furnace has passed 2,111,706 tons output on the original lining with only minor repairs to the stock line. This has been made possible by the improvement in refractories, the last record being made with power-pressed brick, which were first used for blast-furnace linings in 1929. Vacuum power-pressed brick promise even longer life in blast-furnace service. Illustrated. E.J.V.

Silica brick for electric furnace roofs. E. Bonnet. *Jour. Four. Élec.*, **46**, 408–10 (1937); *Chem. Abs.*, **32**, 1581 (1938).—A special silica brick for furnace roofs has the following advantages: it has low thermal conductivity and low thermal expansion above 500° (though high below this temperature); slags produced with fluxes are viscous and do not drip off; it is unaffected by reaction products; pieces falling in the charge do not affect the composition appreciably; it has high mechanical strength at high temperature; and it is cheaper than any other refractory roof brick.

Steel-plant experience with metal encased basic brick. H. S. Robertson. *Steel*, **101** [15] 99–100, 102 (1937).—The use of metal encased basic brick is rapidly replacing acid brick side walls in a basic furnace. In service, the edges of the steel casings exposed to furnace temperatures fuse with the adjacent magnesite to form a monolithic surface highly resistant to the cutting action of hot dust-laden gases and to corrosion by slags. Back from the exposed face, however, the steel remains intact, adding greatly to the strength of the wall at high temperatures and to its resistance to sudden temperature changes. Shrinkage is offset, and spalling tendency is considerably decreased. H.E.S.

Transformation catalysis of silicic acid in the firing of silica. C. Koeppel. *Mitt. Forsch.-Anstalt. Gutehoffnungshütte Oberhausen A.-G.*, **6** [8] 220–24 (1938).—According to recent investigations, the good physical properties of silica brick are due to the transformations of the SiO_2 in the basic mass into types of crystal lattice which are permanent. These transformations take place during firing and require a long time. K. intended to find out whether the transformation could be accelerated by catalyzers without impairing the properties of the brick. Such catalyzers (mineralizers) are usually other oxides and constitute 4 to 20% of the brick, but as all other oxides act, in connection with SiO_2, to reduce the melting

point, their part in the brick should be as small as possible so that the refractoriness is not impaired. As long as oxides produce a crystalline transformation they are useful, but if they form solid solutions with SiO_2 they are unsuitable, as their melting point always lies below that of the cristobalite. Although the processes are not quite clear at present, certain additions can be made which do not affect the good behavior of the quartzite and which make silica firing cheaper. Six references. M.H.

Use of bauxite in the basic open hearth. F. H. SCHÖNWÄLDER. *Stahl & Eisen*, **57**, 1381 (1937).—When washed German bauxite (35 to 40% Al_2O_3, 25 to 30% Fe_2O_3, and 20% or more SiO_2) is introduced into a basic open-hearth slag, along with lime and mill scale, the content of sulfur reaches low values, little or no fluorspar is needed, and tapping is possible 1/4 to 1/2 hr. earlier. L.R.B.

Utilization of dolomite in metallurgical furnaces. G. V. *Argile*, No. 186, pp. 9–11 (1938).—Dolomites, including those that are not pure, can be used widely in steel mills. V. describes methods by which they can be agglomerated and bricked for the construction of hearths. Brick for backwalls of Martin furnaces can be made by tamping a mixture of calcined magnesium, dolomite, and waste from magnesia brick in the framework. Dolomitic linings hold up exceedingly well, some hearths lasting from 12 to 15 years. See "Industrial—," *Ceram. Abs.*, **16** [1] 39 (1937). M.V.C.

X-ray survey of refractories. A. H. JAY AND J. H. CHESTERS. *Trans. Ceram. Soc.*, **37** [6] 209–30 (1938); see *Ceram. Abs.*, **17** [4] 146 (1938). R.A.H.

BOOKS AND SEPARATE PUBLICATIONS

Lining for reservoirs and ladles suitable for soda-ash treatment. J. J. OFFUTT. *Amer. Refrac. Inst. Tech. Bull.*, No. 71, 4 pp. (Aug., 1938).—Soda ash as a refining agent for cast iron is of value in reducing the sulfur content of the metal; it increases the rate of slag formation and produces a more fluid slag. The soda ash is very corrosive on the refractory lining. Refractory slag tests were made by observing the slag penetration in refractory cups, 2 in. in diameter and 3/4 in. deep, after heating to 2850°F for 5 hr. These tests showed a specially fired refractory brick to be superior to a 60% alumina brick and a first-quality stiff-mud brick. The better brick were made by the dry press process; they have a porosity of 12 to 13% and are fired several hundred degrees above normal firing temperatures for first quality fire brick, giving a more complete and stablized mineral development. Lining costs made of these brick are less than 5¢/ton of metal. The best general results were obtained with a dry fireclay base mortar containing no sodium silicate. H.E.S.

PATENTS

Burner refractory brick. ARTHUR DOCKING. Can. 376,648, Sept. 20, 1938 (Nov. 16, 1936). G.M.H.

Cellular insulating refractory. R. C. BENNER AND H. N. BAUMANN, JR. (Carborundum Co.). U. S. 2,136,096, Nov. 8, 1938 (July 1, 1935). The method of producing globular crystalline pellets having multicellular interiors comprises melting a refractory double oxide and pouring the molten material adjacent a gaseous jet impinging thereupon, thus producing drops of the material, and keeping the drops freely suspended until they have solidified.

Cellular refractory. WIRT S. QUIGLEY AND JAY G. COUTANT (Quigley Co., Inc.). Can. 376,100, Aug. 30, 1938 (Aug. 19, 1937; in U. S., Sept. 26, 1936). G.M.H.

Corrected basic refractory. GILBERT E. SEIL. Can. 375,880, Aug. 16, 1938 (May 28, 1937). A refractory material comprises a heat-treated reaction product having as constituents 3 to 25 calcium aluminate, 1 to 25 monticellite, and 0 to 0.5% of a phosphate, with the remainder consisting of calcium orthosilicate, periclase, or a combination of calcium orthosilicate and periclase but no free lime. G.M.H.

Diatomaceous earth product and process of making. ROBERT CALVERT, K. L. DERN, AND G. A. ALLES (Celite Corp.). U. S. 20,844, Sept. 6, 1938 (May 18, 1938); reissue of original U. S. 1,502,547, July 22, 1924. The process for the production of an improved diatomaceous earth filter aid characterized by its relatively high flow rate consists in forming an intimate powdered mixture of diatomaceous earth in finely divided form with a relatively small amount of an alkali-metal fluxing compound adapted to lower the sintering temperature of the diatomaceous earth and of the clay present, the flux being added in amount sufficient to produce a substantial increase in the flow rate of the finely divided product under the subsequent calcining treatment, calcining the m xture in loose uncompacted condition for a time and at a temperature not in excess of about 1900°F and insufficient to sinter the mass but sufficient to produce incipient fusion, the incipient fusion being the condition at which the particles of the powdered mixture under the action of heat begin to show a noticeable tendency to adhere to form weak lumps and produce a calcined product exhibiting, after reduction to a state of fine division, a markedly increased flow rate, and reducing the calcined product to a state of fine division.

Furnace lining, especially of highly heated metallurgical furnaces and particularly linings of furnace gas ports. JEAN GODENNE. U. S. 2,134,248, Oct. 25, 1938 (Dec. 11, 1935).

Furnace wall. D. S. JACOBUS (Babcock & Wilcox Co.). U. S. 2,132,419, Oct. 11, 1938 (Sept. 20, 1935); continuation of Serial No. 229,326 (Oct. 28, 1927).

Hot top. W. B. OGDEN (Valley Mould & Iron Corp.). U. S. 2,133,829, Oct. 18, 1938 (Nov. 20, 1935).

Magnesium oxide refractory. JOHN A. HEANY (Heany Industrial Ceramic Corp.). Can. 377,000, Oct. 11, 1938 (Oct. 12, 1937). G.M.H.

Making flint clay brick. R. P. HEUER AND A. E. FITZGERALD (General Refractories Co.). U. S. 2,131,252, Sept. 27, 1938 (April 3, 1937). The process of producing dense refractory flint clay brick comprises preparing a mix of between 30% and 70% of hard flint clay particles from 3 to 28 mesh per linear in., between 70% and 30% of hard flint clay particles below 48 mesh per linear in., and between 2% and 5% of bentonite, the flint clay containing between 35% and 45% of alumina and including not more than 5% of calcined clay material, molding the mix into brick under a molding efficiency above 90%, and firing the brick at a minimum temperature of one pyrometric cone below the temperature producing maximum bulk specific gravity when firing lumps of the particular flint clay, the fired brick when reheated at 1600°C for 5 hr. showing a linear shrinkage of not more than 1%.

Mullitic cast refractory. BUNPEI YOSHIKI (Corning Glass Works). Can. 375,955, Aug. 23, 1938 (Sept. 14, 1937). A refractory product comprises mullite and corundum crystals bonded with cordierite. G.M.H.

Producing anhydrous neutral magnesium carbonate. I. G. FARBENIND., A.-G. Ger. 662,585, June 23, 1938 (May 19, 1934); IV*b*/12*m*. 3. Dolomite or limestone is caused to react with magnesium chloride liquor at a temperature over 150°C and at a pressure which is exerted by the partial pressure of the carbonic acid. Upon release of the pressure, the magnesium carbonate is separated from the liquor. D.A.B.

Producing fireproof ceramic products. DIDIER-WERKE, A.-G. Ger. 662,755, June 23, 1938 (Dec. 5, 1929); VI/80*b*. 12.04; addition to Ger. 602,827 (*Ceram. Abs.*, **14** [7] 167 (1935)). Leaning material (88 to 98%) such as chamotte, etc., and at the most 12% clay, kaolin, etc., as binding agents are mixed with electrolyte mixing water, and the mass is fabricated by tamping, cutting, and pressing. The electrolyte mixing water is added just after the leaning material and the binding material are mixed with a little of the mixing water. D.A.B.

Producing fireproof hydraulic-set materials. ALPHONS CUSTODIS. Ger. 663,342, July 7, 1938 (Nov. 10, 1933); VI/80*b*. 8.15. Fireproof material is made from alumina cement; materials such as chamotte or siliceous materials such as silica brick fragments are added as leaning material. The hydraulic binding agent may be substituted

in part by other material; fireproof clay is used with chamotte, and luting sand with siliceous material. D.A.B.

Producing fireproof insulation products from basic magnesium carbonate. LÜNEBURGER ISOLIERMITTEL UND CHEMISCHE FABRIK KOM.-GES. K. HÖBOLD & Co. Ger. 663,028, June 30, 1938 (Feb. 17, 1936); VI/80*b*. 9.08. Heat-insulating products are made from cast magnesium carbonate. A stream of steam is directed on the cast mass (still moist) for the purpose of making it firm. D.A.B.

Producing practically nonshrinking fireproof articles. HEINRICH KOPPERS INDUSTRIEELE MIJ. N.V. Ger. 658,893, March 24, 1938 (Nov. 14, 1931); VI/80*b*. 8.18. Fine and coarse grained fireproof material such as mullite, kyanite, magnesia, etc., and small amounts of binding agent are mixed together, cast, and fired. A shrinkless very highly fired or sintered fireproof material is used as the fine-grained substance; a shrinking slightly sintered material is used as the coarse-grained substance. D.A.B.

Producing sagger lubricant. PORZELLANFABRIK HEINRICH & Co. Ger. 658,523, March 17, 1938 (March 6, 1937); VI/80*b*. 8.15. Carbon, in the form of coke, is the only substance added to the raw materials for producing sagger lubricants to be used with saggers fashioning ceramic articles upon firing. D.A.B.

Producing silica brick. HEINRICH KOPPERS, G.M.B.H. Ger. 659,921, April 14, 1938 (Oct. 3, 1934); VI/80*b*. 8.06. Silica brick consisting essentially of tridymite is made by forming and sintering a silica mass to which an addition of alumina-free alkali compounds and other oxides such as iron oxide and magnesia are mixed in addition to the lime. The alumina-free alkali is added in the form of caustic soda, and the lime in the form of calcium hydroxide. D.A.B.

Recovering alumina and potash from aluminous ores. R. McC. MOFFAT (Aluminum, Inc.). U. S. 2,134,793, Nov. 1, 1938 (Nov. 4, 1932; renewed May 11, 1938).

Refractories. N. P. PITT, A. C. HALFERDAHL, AND F. E. LATHE. Brit. 493,773, Oct. 26, 1938 (April 13, 1937).

Refractory. J. T. SINGEWALD, JR. (Standard Lime and Stone Co.). U. S. 2,133,672, Oct. 18, 1938 (April 1, 1936). A magnesia-containing refractory in the form of a reaction product consists of approximately 70% refractory constituents and 30% bonding constituents in which the refractory constituents are periclase and compounds of magnesia and the bonding constituents are compounds of CaO with SiO_2 and R_2O_3 oxides, the refractory containing between 45 and 50% of magnesium oxide based on the weight of the refractory and containing no free lime.

Refractory articles. CARBORUNDUM CO. Brit. 492,215, Sept. 28, 1938 (March 2, 1937).

Refractory ceramic materials. GENERAL ELECTRIC CO., LTD., AND M. PIRANI. Brit. 492,394, Oct. 5, 1938 (April 5, 1937).

Refractory for molten glass. JOHN C. HOSTETTER (Corning Glass Works). Can. 376,575, Sept. 20, 1938 (April 29, 1937); see *Ceram. Abs.*, **17** [4] 141 (1938). G.M.H.

Terra Cotta

Ceramic building products—manufacture, qualities and properties, placing, upkeep, and application. F. CHALAMEL. *Rev. Matériaux Construction Trav. Publics*, No. 337, pp. 145–49B; No. 338, pp. 164–70B; No. 339, pp. 180–86B (1937); No. 340, pp. 9–11B; No. 342, pp. 20–25B; No. 343, pp. 33–37B (1938).—C. deals with ceramic building materials and their manufacture, discussing the definition and classification of products, pastes (raw materials, nature, preparation, and composition), glazes, coloring materials, drying, firing, grading, defects, manufacture, forms and dimensions, use, qualities, properties, placing, upkeep, and the principal ceramic products used in building including (1) porous pottery from fired clay, *viz.*, brick and rough walling, tile, paving brick, and pipe; and (2) ordinary refractory brick, architectural faience, glazed tile, and coarse and fine faience tile. See *Ceram. Abs.*, **17** [5] 198 (1938). M.V.C.

Ceramic packing designed for gas washer. GENERAL REFRACTORIES CO. *Steel*, **101** [21] 58 (1937).—A new tile made of a dense acid-resisting fireclay brick possessing high physical strength is illustrated. Its more important applications include blast-furnace gas washers, coke and gas scrubbers, acid-concentrating towers, chemical-absorbing towers, and cooling tower packing. It is known as GRCO Drip Point Grid Tile. H.E.S.

Faience for structural steel and concrete. E. HOLDEN. *Master Builder*, **42** [902]417–18 (1937).—Clay molding is the oldest form of handicraft, and articles of faience of ancient times have been found which are still wonderfully preserved. These include glazed panels and brick; enameled baths, among which that of the Queen's bath chamber at Knossos with its antisplash edge turned slightly inward is described; sewage pipes socketed in a way opposite to that of modern pipe; jars, etc. The absolute permanence of faience makes it the economic, esthetic, and sure means of protecting and decorating modern forms of constructional steel and concrete. M.V.C.

Modern tilemaking. ANON. *Indian & Eastern Engr.*, **82** [1] 71–72 (1937).—The Atritor Unit Pulverizer for dehydrating and pulverizing clay used for tilemaking, which greatly shortens the process and gives a finer texture tile, is described. A tile made by the wet process gave a Brinell number of 74 whereas the tile made by the semidry Atritor process gave a number of 100. In a shotblasting test an old type of tile lost 6.60% by weight whereas the new type lost only 5.18%. A.P.S.

Porcelain pipe at WHAM. JOHN J. LONG, JR. *Electronics*, **11** [10] 24–25 (1938).—To eliminate corrosion troubles by water, a porcelain pipe system for cooling transmitter tubes of Station WHAM was installed. This new system gives trouble-free operation, and the water can be used without changing for a year. L. gives a detailed description of the installation. Illustrated. H.T.

PATENTS

Ceramic manufacture. W. E. DUSKEY (United States Quarry Tile Co.). U. S. 2,132,257, Oct. 4, 1938 (Dec. 7, 1936). An extruded ceramic article of manufacture having a body made of laminations of different ceramic constituents, and an extruded smooth exposed face in which the laminations terminate and provide variegated colors for the exposed face, extruded side and setting faces, and rough end faces in which the laminations terminate.

Fireplace wall and other tile. J. G. M. JEFFREY. Brit. 491,625, Sept. 21, 1938 (Aug. 21, 1937).

Flowerpot. GUSTAF HAGLUND. U. S. 2,130,234, Sept. 13, 1938 (Feb. 27, 1937).

Production of molded ceramic bodies, ceramic coatings, etc. O. BORMANN. Brit. 492,576, Oct. 5, 1938 (Jan. 4, 1937). Brit. 492,577, Oct. 5, 1938 (April 5, 1937); addition to 492,576.

Roofing tile. ZEIPAUER DACHSTEIN & BRAUNKOHLENWERKE. Ger. 657,092, Feb. 10, 1938 (Jan. 4, 1936); V/37*c*. 1.06. Roofing tile is designed with flanges which project up and down. The upper flange has a grooving on its upper side for the purpose of overlapping other tile. D.A.B.

Tile-mounting structure. A. H. STEWART. U. S. 2,135,118, Nov. 1, 1938 (April 18, 1936).

Vitreous tubing production. THEODOR PFAFF (Canadian General Electric Co., Ltd.). Can. 375,761, Aug. 16, 1938 (June 10, 1936). G.M.H.

Whiteware

Ceramic materials for high-frequency insulation. Group II, Titanium compounds: I. SHIN-ICHI SUZUKI. *Jour. Electrochem. Assn. Japan*, **6** [1] 6–13 (1938).—S. investigated the high-frequency insulating ceramic bodies which consist mainly of titanium compounds. He studied the utilization of waste titanuim compounds of the alumina, fertilizer, and iron-sand industries. The specific resistances at various temperatures of 24 kinds of titanium porcelain and 32 kinds of sintered rutile bodies are discussed. Specific resistances at high temperature of titanium porcelain are inferior to those of good steatite bodies. The effects of alkali metals are comparatively slight, but the molecular ratio of TiO_2 and Al_2O_3 has considerable effect. High-alumina bodies give good results, and decreasing Al_2O_3 and SiO_2 and increasing TiO_2 reduce the resistance. Sintered rutile bodies have no superiority. Y.K.

Determining the hardness of porcelain and stoneware glazes. A. I. AVGUSTINNIK AND L. M. SHCHEGLOV. *Zavodskaya Lab.*, **7**, 336–39 (1938).—The Schor method is quick and simple. Permissible data on glaze hardness are given; for a porcelain glaze it should not be under 106, and for stoneware glaze, not under 67. P.B. & E.S.

Glaze symposium: Problems in whiteware glazes. EDWARD SCHRAMM. *Bull. Amer. Ceram. Soc.*, **17** [11] 436–40 (1938). **Application of glazes.** LAWRENCE H. BROWN. *Ibid.*, pp. 441–42. **Elimination of glaze defects by control of the glaze consistency.** W. R. MORGAN AND W. B. MCDEVITT. *Ibid.*, pp. 443–44. **Transformation point of glazes.** F. H. NORTON. *Ibid.*, p. 445. **Measurement of kind and degree of stress existing between glaze and body.** F. H. NORTON. *Ibid.*, p. 445. **Softening point of glazes.** ARTHUR S. WATTS. *Ibid.*, pp. 446–47; see *Jour. Amer. Ceram. Soc.*, **21** [7] 239–51 (1938).

Intaglio printing in the dinnerware industry. G. H. STAPLEFORD. *Bull. Amer. Ceram. Soc.*, **17** [11] 447–50 (1938).

Properties of dinnerware bodies prepared by the dry-mix method. R. C. MEEKER. *Bull. Amer. Ceram. Soc.*, **17** [11] 435-36 (1938).

Recent developments in electrical insulating materials. L. HARTSHORN. *Jour. Sci. Instruments*, **15** [7] 217–22 (1938).—H. surveys the field of electrical insulating materials. The new ceramic materials mentioned are the steatite and rutile groups. The electrical and mechanical properties of 28 types of insulating material are tabulated. J.L.G.

Recent developments in zirconium glazes and effect of various materials on the results. C. H. COMMONS, JR. *Bull. Amer. Ceram. Soc.*, **17** [11] 433–34 (1938).

Talc porcelain: XIII, Thermal conductivity. SEIJI KONDO AND S. SUZUKI. *Jour. Soc. Chem. Ind. Japan*, **41** [2] 35B (1938).—To keep the change in temperature in complete sinus form, special care was given to the dependence of the wave period on the size of the specimens. The thermal conductivity increases with a decrease in the silicic acid content and an increase in the alumina or magnesium oxide content; it also increases with rising temperature. Although the temperature coefficient of thermal conductivity varies with the sample, it is larger, the smaller the temperature coefficient (negative) of the specific resistance at higher temperatures. For Parts **IX–XII** see *Ceram. Abs.*, **17** [5] 191 (1938). M.V.C.

Technical control of thermal breakdown of insulators. H. LUEDER, W. SCHOTTKY, AND E. SPENKE. *Naturwissenschaften*, **24**, 61 (1936); *Brit. Chem. Abs.-B*, **55** [13] 282 (1936).—The variation of temperature in an insulator under an electric potential can be compared with the variation in lateral bending of a rod subjected to pressure along its axis.

Testing the suitability of kaolins for porcelain manufacture. R. RIEKE. *Ber. Deut. Keram. Ges.*, **18** [6] 270–72 (1937).—R. justifies the methods of investigation used in making the tests. E.J.V.

PATENTS

Assembling electric insulators. O. G. CALLAND (Ohio Brass Co.). U. S. 2,135,326, Nov. 1, 1938 (Dec. 27, 1937).

Ceramic structures such as electric insulators, etc. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 493,599, Oct. 26, 1938 (March 20, 1937).

Conductor support. J. J. TAYLOR (Ohio Brass Co.). U. S. 2,135,360, Nov. 1, 1938 (Feb. 20, 1936).

High-tension electric insulators. C. LORENZ A.-G. Brit. 490,884, Sept. 7, 1938 (Nov. 24, 1936).

High-voltage bushings. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 493,826, Oct. 26, 1938 (March 23, 1937).

Insulator. J. J. TAYLOR (Ohio Brass Co.). U. S. 2,-135,362, Nov. 1, 1938 (Oct. 27, 1937).

Lavatory unit. GEORGE SAKIER (Accessories Co., Inc.). U. S. 2,130,196, Sept. 13, 1938 (March 31, 1936).

Manufacture of lead frits for ceramic glazes. GOODLASS WALL & LEAD INDUSTRIES, LTD., AND N. J. READ. Brit. 494,060, Nov. 2, 1938 (Jan. 19, 1937).

Manufacture of spark plugs. AC-SPHINX SPARKING PLUG CO., LTD., AND D. H. CORBIN. Brit. 492,315, Sept. 28, 1938 (March 19, 1937).

Multiple arcing gap. H. L. RORDEN (Ohio Brass Co.). U. S. 2,135,352, Nov. 1, 1938 (Oct. 25, 1935).

Saggers. WILTSHAW & ROBINSON, LTD., AND T. NEWMAN. Brit. 491,427, Sept. 14, 1938 (Feb. 14, 1938).

Spark plug. AC-SPHINX SPARKING PLUG CO., LTD., AND D. H. CORBIN. Brit. 492,069, Sept. 28, 1938 (June 2, 1937). THOMAS DUKELOW. U. S. 2,136,206, Nov. 8, 1938 (May 13, 1937). H. L. HALL. Brit. 492,113, Sept. 28, 1938 (May 18, 1937). B. HOPPS AND A. M. LODGE. Brit. 492,313, Sept. 28, 1938 (March 19, 1937). A. JAKOB, M. KOLOWRAT, AND E. KAUFMANN. Brit. 492,134, Sept. 28, 1938 (Dec. 15, 1936). G. M. PAULSON (B. G. Corp.). U. S. 2,135,240, Nov. 1, 1938 (Sept. 12, 1932). HECTOR RABEZZANA (General Motors Corp.). U. S. 2,135,324, Nov. 8, 1938 (June 1, 1937). H. A. VILA. U. S. 2,135,297, Nov. 1, 1938 (Sept. 25, 1937). W. J. VINCENT. U. S. 2,130,208, Sept. 13, 1938 (March 3, 1937).

Spark plug. GEORGE MARCHESSEAULT. Can. 376,156, Aug. 30, 1938 (Aug. 1, 1936). G.M.H.

Support. J. J. TAYLOR (Ohio Brass Co.). U. S. 2,135,-361, Nov. 1, 1938 (Aug. 13, 1936).

Suspension insulator. J. J. TAYLOR AND F. G. BOVARD (Ohio Brass Co.). U. S. 2,135,359, Nov. 1, 1938 (April 20, 1935).

Wall-tile construction. R. J. BERGEZ. U. S. 2,132,982, Oct. 11, 1938 (May 4, 1937). A wall-tile construction comprises a supporting layer of cement, tile placed against the cement with their edges abutting each other, the faces of the tile being glazed and of less area than the bases of the tile, whereby the edges of the faces of adjacent tile are spaced from each other to provide grooves that bound all sides of each tile, and a cement filling the grooves and being spaced from the layer of cement that supports the tile by the lower edges of the tile abutting the lower edges of adjacent tile.

Equipment and Apparatus

Automatic compensation of flowmeters for pressure variations. ROGER K. TAYLOR. *Jour. Amer. Chem. Soc.*, **59** [9] 1605 (1937).—T. describes a device for maintaining constant delivery rates from flowmeters, irrespective of pressure variations at the flowmeter outlets. Illustrated. F.G.H.

Automatic high-pressure regulator. H. BRENDLEIN. *Chem. Fabrik*, **11**, 440 (1938).—B. describes an electromagnetic regulator which is said to maintain pressures constant to ± 0.5% at 10 to 350 atm. E.P.

Characteristics of sifting processes and sifting apparatus. E. RAMMLER. *Chem. App.*, **25** [17] 275–79; [18] 289–94

(1938).—R. discusses factors affecting the capacity and efficiency of sifting apparatus in regard to quantity and quality. Formulas and numerical values are developed from which the ratio of useful, total, and free sifting area and the ratios of grain sizes in the sifted product can be determined and compared for different apparatus. Curves show the conditions for different products. 13 references. M.H.

Continuous gas indicator. GRIFFIN AND TATLOCK, LTD. *Jour. Sci. Instruments*, **15** [8] 278–79 (1938).—This indicator operates on the viscosity-effusion bridge principle. It permits determination of fluctuations in the composition of a flowing or stationary gas or vapor mixture with only a small time lag. Price is £95. Two diagrams. J.L.G.

Cracks in machine shafts. EDWARD INGHAM. *Brit. Clayworker*, **47** [557] 179–81 (1938).—The causes and prevention of cracking of important shafts in machinery are dealt with. R.A.H.

Crushing and rock haulage at Leeds plant. ANON. *Concrete, Cement Mill Ed.*, **46**, 182–83 (1938).—The Leeds (Ala.) plant of the Universal Atlas Cement Co. has installed a new crusher house with a 42-in. gyratory crusher and a hammer mill. The new rock-haulage system is controlled entirely by one man and is of the third-rail type, utilizing single cars. W.D.F.

Efficient and convenient cooling and freezing bath. G. J. BOUVOUCOS. *Soil Sci.*, **46** [1] 21–22 (1938).—Illustrated. G.R.S.

Electron microscope. SIEMENS. *Elec. Rev.*, **123** [3174] 419 (1938).—The first electron microscope, completed by B. von Bories and E. Ruska in 1933, gave a magnification of 12,000 diameters. An electron microscope capable of a magnification of 100,000 diameters, demonstrated by Siemens of Berlin, costs about £5000. The voltage on the cathode-ray "gun" is 80,000 v. A contour or outline image of the viewed object is obtained. Colors and shades can not be seen. J.L.G.

Electronic recording analytical balance. R. H. MULLER AND R. L. GARMAN. *Ind. Eng. Chem., Anal. Ed.*, **10** [8] 436–40 (1938).—An electronic recording analytical balance is described which is direct-reading, rapid, and sensitive. The complete instrument costs about $500, excluding labor. Illustrated. F.G.H.

Electrostatic separation. HERBERT BANKS JOHNSON. *Eng. Mining Jour.*, **139** [9] 37–41, 51 (1938).—Patent literature on static and electrostatic separation since 1870 is listed and briefly reviewed. J.L.G.

Furnace temperatures measured by Rayotube. LEEDS & NORTHRUP CO. *Steel*, **101** [26] 58 (1937).—The temperatures of heat-treating furnaces are accurately measured by the Rayotube, which is mounted outside the furnace and pointed through a target tube in line with the work. H.E.S.

Heat of hydration of cement. S. C. PIERCE AND H. McC. LARMOAR. *Concrete & Constructional Eng.*, **29** [4] 293 (1934).—An inexpensive apparatus for determining the heat of hydration of cement is described. F.G.H.

Improved apparatus for measuring strength of ceramic raw materials and bodies after drying. HANS LEHMANN AND MARIA-THERESA SCHULZE. *Sprechsaal*, **71** [17] 207–208 (1938). M.V.C.

Laws of drying of solids. K. KRÖLL. *Z. Ver. Deut. Ing.*, **80** [32] 958–62 (1936).—The present status of the drying phenomenon is discussed. Three stages can be distinguished; the drying velocity is determined in the first stage mainly by the nature and velocity of the drying agent, in the second by the escape of humidity from the interior to the exterior of the solid to be dried, and in the third by the inner resistance of the solid. A theory which takes into account the movement of liquids by capillary forces is developed. 21 references. M.H.

Luminescence and its applications. J. T. RANDALL. Read before Royal Society of Arts; abstracted in *Electrician*, **118** [3062] 183 (1937).—R. describes the mechanism of and applications of luminescence to lamps, signs, and cathode-ray tubes. The physical basis of luminescence is discussed in detail. The use of luminescent powders on the inside of mercury-discharge lamps is mentioned. The use of neon discharge as the exciter of the luminescence is also noted. Zinc silicate powders are extremely responsive; a ratio of 16 to 1 luminescent efficiency has been obtained experimentally with powders of this type. H.K.R.

Measuring temperature in the glass industry. ALFRED SCHWARTZ. *Verre & Silicates Ind.*, **9** [26] 306–309; [27] 313–17 (1938).—The operation of radiation pyrometers is based on the law of radiation according to which the temperature of a heat source is deduced from the intensity of the radiation. An "aestometer" applying this method is described. It is mounted near the furnace in a water-cooled housing and sights through an incandescent tube which extends sufficiently far into the furnace to acquire the same temperature as the latter. In another satisfactory apparatus an obturator shields the objective until a thin safety filament is burned; when the cell of the aestometer emits rays, it gives an electric current which is transmissable as in the case of thermocouples; this permits the reading, registering, and control center to be located arbitrarily. A pocket pyrometer for checking thermal conditions of fusion contains no electric instrument but a spiral of 2.5 mm. diameter on 0.025 mm. in a bimetal which is a receiver ultrasensitive to radiation. A needle attached to the spiral moves on a dial indicating temperature so that sighting and temperature reading can be accomplished without moving the eye. For economic thermal functioning of an installation and for attaining the fusing temperature with optimum utilization of fuel, combustion must be controlled at various points: an aestometer in a water-cooled casing is used to control the preheating air; thermocouples suffice for controlling the temperature of the fuel gas; for controlling the temperature of the glass during working, Pt-Pt Rh thermocouples in refractory mounting are used because the danger of destruction is less than in the fusing tank. Control of the annealing temperature is also important. Recorders, temperature indicators, and commutators are described and illustrated. Thermostats for regulating temperatures automatically are discussed. M.V.C.

More complex fusible metals. ANON. *Metal Ind.* [London], **50** [10] 298 (1937).—The properties and uses of some of the rarer base metals and the alloys of indium and gallium are given. H.E.S.

Notched-bar impact testing. JOINT COMMITTEE ON MATERIALS AND THEIR TESTING. 230 pp. Price 3s 6d. *Trans. Manchester Assn. Engrs. Reprint; Jour. Soc. Glass Tech.*, **22** [91] A186 (1938).—The following papers are contained in this publication, which is a valuable summary of the present knowledge of the subject: (1) "Impact testing from a physical standpoint," by R. V. Southwell; (2) "Some aspects of the notched-bar test," by L. W. Schuster; (3) "Development and present position of continental research on the notched-bar impact test," by M. Moser; and (4) "Discussion on impact test," by R. K. Haskell and H. C. Mann. A general discussion on the subject is given. Forms of apparatus are described for carrying out impact tests on metallurgical materials, particularly steels and cast irons, the interpretation of the results obtained forming the main basis of discussion. Further work is desired on the effects of scale, velocity of impact, and crack propagation before a satisfactory international method of notched-bar impact testing can be formulated. E.P.

Objective measurement of color. J. W. PERRY. *Jour. Sci. Instruments*, **15** [8] 270–77 (1938).—The general principles of direct photoelectric color measurement and their application to Blancometers are considered. Two categories of such color measurement are distinguished. P. describes the Blancometers and their application to the measurement of color differences. Illustrated. See "Principles—," *Ceram. Abs.*, **16** [10] 294 (1937). J.L.G.

Portable carbon dioxide and temperature indicator. CAMBRIDGE INSTRUMENT CO., LTD. *Jour. Sci. Instruments*, **15** [7] 245–46 (1938).—The carbon dioxide meter draws gas past two heated coils and compares their resistance with the resistance of two coils immersed in air

saturated with water vapor. The temperature indicator is a galvanometer and thermocouple. Illustrated. J.L.G.

Powder measurer. R. P. WODEHOUSE. *Ind. Eng. Chem., Anal. Ed.*, **10** [8] 423–24 (1938).—An instrument is described which is designed to measure (rapidly and fairly accurately) powders of widely varying bulk in small amounts by weight and to pour them into cylindrical vials, etc., of small diameter. Illustrated. F.G.H.

Practical experiences in de-airing heavy clay goods. F. H. CLEWS. *Trans. Ceram. Soc.*, **37** [6] 231–40 (1938); see *Ceram. Abs.*, **17** [5] 193 (1938). R.A.H.

Practical viscometry. O. AMSEL AND H. SEELES. *Chem. Fabrik*, **11**, 240–45 (1938).—Viscometric calculations are simplified by the use of nomographs and specially constructed slide rules for transforming the characteristic indices of a liquid according to different systems and for calculating the viscosities of liquid mixtures. E.P.

Pyrometry. R. W. D. *Verre & Silicates Ind.*, **9** [6] 64–66 (1938).—Optical pyrometers and the principles on which they function are discussed. D. describes instruments which function from the effect of heat radiated by the hard body and those based on luminous radiations where (1) the intensity of a radiation of definite wave length or color or (2) the relative intensity of variations of definite wave lengths is used for measuring the temperature. M.V.C.

Reduction ratio curves for crushing and grinding. FRED C. BOND. *Eng. Mining Jour.*, **139** [7] 48–49 (1938).—The term "reduction ratio" in a crushing or grinding operation commonly means the ratio between the diameter of the largest piece in the feed and that of the largest piece in the product. Occasionally, this ratio is based upon the crusher opening on the open side rather than upon the diameter of the largest piece in the product. The more significant reduction ratio of the average piece, however, may be far different from that of the largest. B. calculates this average value graphically from data obtained from complete screen analyses on feed and product. The cumulative weights (%) retained are plotted against ordinal numbers assigned to the screen sizes: No. 41 to 200-mesh, No. 42 to 150-mesh, No. 43 to 100-mesh, etc. A difference of one size number is given a constant interval. The distance between the plotted curve of the feed and that of the product (measured along the ordinal number axis) at any selected point on the cumulative-weight axis represents the reduction ratio at that point. The numerical value of the ratio is one-half the distance indicated, since the interval between screens is the square root of two. The median reduction ratio is the ratio at 50% cumulative weight retained. The distances between feed and product curves are measured with dividers, and the reduction-ratio curve is plotted directly on the same sheet, using the same cumulative-weight axis but a double ordinal unit to each unit on the new reduction-ratio scale in order to halve the divider reading. Three reduction-ratio curves indicate the results of tests on gold ore. ABSTRACTER'S NOTE: There is a rather serious mistake in the original article in specifying the measurement of a horizontal distance where a vertical one is meant (at least as the author graphs it), perhaps a printer's error. J.L.G.

Ruggles-Coles "XB" drier. HARDINGE CO. *Mining Jour.* [Phoenix], **22** [6] 41 (1938).—Chemicals, finely divided clays, silica, etc., are dried in new equipment which does not allow gases of combustion or large quantities of air to come in contact with the material being dried. P.G.H.

Sintering in rotary kilns. F. L. SMIDTH CO. *Steel*, **101** [25] 71–72, 74 (1937).—The problem of sintering ore fines, blast-furnace flue dust, etc., is discussed. Several plants are illustrated. H.E.S.

Snap pyrometer. CAMBRIDGE INSTRUMENT CO., LTD. *Jour. Sci. Instruments*, **15** [8] 277–78 (1938).—When sighted on the hot object with the shutter open, the instrument immediately registers the temperature on a calibrated pointer galvanometer. The pointer remains at the reading obtained until reset. A photocell is used to actuate the galvanometer. Illustrated. J.L.G.

Transport of water through heavy clay soils: III. E. C. CHILDS. *Jour. Agr. Sci.*, **26** [4] 527–45 (1936).—The diffusion theory of water through soil alone accounts qualitatively for the water movement from wet to dry soil and fits the best experiments numerically. Illustrated. P.S.D.

Viscometer. A. GALLENKAMP AND CO., LTD. *Jour. Sci. Instruments*, **15** [6] 210 (1938).—This instrument is intended for materials of high viscosity, in the range 50 to 10^9 poises. It consists of a solid cylinder 29/32 in. in diameter and $2^3/_8$ in. long rotating in an outer cylinder $1^1/_{64}$ in. in diameter, giving an annular space of about $^1/_{20}$ in. to be filled with 10 ml. of the sample to be measured. A steel wire 6 in. long forms the torsion suspension. The size of wire is chosen to suit the range required. The apparatus is designed to operate in a water bath. Viscosity is measured by rotating the torsion head through 90° and observing the position of the pointer attached to the inner cylinder at half-minute intervals. Viscosity is calculated from the equation $\eta = K\theta/\phi$ poises, where K is a constant, θ = torque in degrees, and ϕ = velocity of rotation of the inner cylinder in degrees per second. Illustrated. J.L.G.

Viscosity measurement. M. R. CANNON AND M. R. FENSKE. *Ind. Eng. Chem., Anal. Ed.*, **10** [6] 297–301 (1938).—Viscosity and viscosity-temperature coefficients are valuable identifying properties of pure compounds and petroleum fractions. The authors discuss the operating characteristics of simple modified Ostwald viscometers that cover a wide range of viscosity with accuracy. The important sources of error in capillary viscometers are analyzed briefly, and equations for computing the necessary corrections are given. Comparisons are made with other types of capillary viscometers, showing that the modified Ostwald viscometer is equal in accuracy to any available. Illustrated. F.G.H.

BOOKS AND SEPARATE PUBLICATIONS

Flotation process applied to the concentration of Washington medium and low-grade magnesite ore for the production of magnesium metal or refractories. DWIGHT L. HARRIS. *Wash. State Coll., State Electromet. Research Labs. Bull.*, **Q**, 23 pp. (1937).—Preliminary studies indicate that a large part of the silica can be eliminated from magnesite ore. Separation of the calcite by flotation has not yet been obtained. A.G.S.

Methods for detecting and determining carbon monoxide. L. B. BERGER AND H. H. SCHRENK. *U. S. Bur. Mines Tech. Paper*, No. 582, 30 pp. Govt. Printing Office, Washington, D. C. Price 10¢. The methods generally used for the detection and determination of carbon monoxide, the range of concentrations that may be determined, and the accuracy of the determination are discussed. The reactions or principles upon which the methods are based and the technique of operation are described briefly. R.A.H.

Pressure losses resulting from changes in cross-sectional area in air ducts. A. P. KRATZ AND J. R. FELLOWS. *Univ. Illinois Eng. Expt. Sta. Bull.*, No. 300, 56 pp. (1938).—The losses in total head or pressure resulting from abrupt changes in the cross section, symmetrically and nonsymmetrically to the longitudinal axis of the duct, are investigated exhaustively. Losses are the same whether the change occurs on the suction or the outlet side of the fan. New formulas are derived and old formulas are checked. M.H.

Respiratory protective devices approved by the Bureau of Mines. H. H. SCHRENK. *U. S. Bur. Mines Information Circ.*, No. 7030, 9 pp. Free. S. lists all respiratory protective devices approved as of May 20, 1938. R.A.H.

Technique for use of the impinger method. CARLETON E. BROWN AND H. H. SCHRENK. *U. S. Bur. Mines Information Circ.*, No. 7026, 20 pp. Free. The authors describe the impinger method used by the Bureau of Mines to determine number concentration of dust in atmospheres known to contain or suspected of containing

pneumoconiosis (silicosis and asbestosis) producing particulate matter. R.A.H.

PATENTS

Air-controlled water jig and valve therefor. B. M. Bird and F. P. Smith (Jeffrey Mfg. Co.). U. S. 2,132,377, Oct. 11, 1938 (July 23, 1934; renewed June 22, 1938).

Apparatus for treating mineral materials. B. M. Bird and E. F. Muller (Jeffrey Mfg. Co.). U. S. 2,132,375, Oct. 11, 1938 (July 23, 1934).

Automatic cutting machine for brick, etc. Leopold Poussel (Établissements Favant). U. S. 2,134,374, Oct. 25, 1938 (Aug. 31, 1937).

Automatic mixing and fine-grinding mill for colors, etc. Leo Theiner. U. S. 2,134,897, Nov. 1, 1938 (April 17, 1937).

Ball-mill liner. Edward M. Houghton (M. J. O'Brien, Ltd.). Can. 376,444, Sept. 13, 1938 (April 5, 1937). G.M.H.

Brickmaking machine. T. C. Fawcett, Ltd., D. L. Fawcett, and A. E. Bottomley. Brit. 492,389, Oct. 5, 1938 (March 24, 1937).

Brick and tile cutter. H. K. King (Chambers Bros. Co.). U. S. 2,131,562, Sept. 27, 1938 (Jan. 28, 1937).

De-aired press for clay cutter or clay mixer for breaking up ceramic material. Richard Raupach Maschinenfabrik Görlitz, G.m.b.H. Ger. 657,758, Feb. 24, 1938 (July 18, 1935); VI/80*a*. 26. Chamotte, kaolin, porcelain, etc., are broken up by the action of a revolving device whose motion is oblique to the direction of feeding and which pulverizes the material upon its entrance into the degassing chamber. The pulverizing device consists of a brush roller. D.A.B.

Drying pottery ware, etc. W. Boulton, Ltd., and F. Beardmore. Brit. 491,988, Sept. 28, 1938 (May 14, 1937). W. Boulton, Ltd., R. T. Lewis, and C. Bailey Brit. 493,852, Oct. 26, 1938 (April 15, 1937).

Dust seal for crushing machines. M. R. Hull, B. S. Morrow, and W. H. Casto (Allis-Chalmers Mfg. Co.). U. S. 2,134,876, Nov. 1, 1938 (Feb. 16, 1932).

Dust seal for gyratory crushers. R. C. Newhouse and G. F. De Wein (Allis-Chalmers Mfg. Co.). U. S. 2,134,885, Nov. 1, 1938 (Aug. 25, 1934).

Engobing and dipping plant for ceramic articles. Wilhelm Kümmel. Ger. 663,058, June 30, 1938 (March 18, 1936); VI/80*a*. 58. Ceramic articles are engobed and dipped in a device provided with a continuous revolving rocking feeder. A device for raising and lowering the container holding the dipping liquid is switched on and off by the rocking of the feeder. D.A.B.

Grinding and mixing hammer mill. William E. Williams (Delbert T. Hulse). Can. 375,837, Aug. 16, 1938 (May 22, 1937). G.M.H.

Gyratory crushing machine. P. B. Brown. U. S. 2,135,324, Nov. 1, 1938 (Nov. 11, 1937).

Jig. J. G. Attwood (Jeffrey Mfg. Co.). U. S. 2,132,380, Oct. 11, 1938 (March 4, 1935). B. M. Bird and E. F. Muller (Jeffrey Mfg. Co.). U. S. 2,132,378, Oct. 11, 1938 (Jan. 8, 1935; renewed June 22, 1938).

Jigging. B. M. Bird (Jeffrey Mfg. Co.). U. S. 2,132,376, Oct. 11, 1938 (July 23, 1934).

Method and apparatus for applying glaze to ceramic articles. H. V. Schweitzer. Brit. 490,770, Aug. 31, 1938 (Feb. 27, 1937).

Molds and cores used in casting metals, glass, etc. J. Robinson. Brit. 492,718, Oct. 5, 1938 (March 24, 1937).

Pyrometric cone. H. E. CoVan and G. A. Bole (Standard Pyrometric Cone Co.). U. S. 2,129,912, Sept. 13, 1938 (July 30, 1936).

Roller and breast grinding mill. Charles Carruthers. Can. 376,136, Aug. 30, 1938 (Nov. 7, 1936). Charles Carruthers and John R. Torrance. Can. 376,138, Aug. 30, 1938 (Nov. 7, 1936). G.M.H.

Roller grinding mill. Charles Carruthers. Can. 376,137, Aug. 30, 1938 (Nov. 7, 1936). G.M.H.

Rotary muffle furnace. Paul Jordan (American Lurgi Corp.). U. S. 2,131,665, Sept. 27, 1938 (June 9, 1937).

Separating magnetic material. R. S. Dean and C. W. Davis. U. S. 2,132,404, Oct. 11, 1938 (Feb. 17, 1934). The method of separating minerals containing a paramagnetic substance comprises subjecting subdivided particles thereof to a heat treatment to impart thereto a high coercive force, converting the treated mineral particles into permanent magnets, and then effecting the desired separation by an action including the subjection of the mineral particles to an alternating magnetic field, the strength of which is not greater than the coercive force of the magnetized particles.

Separation and gas treatment of gas-dust mixtures. Kurd von Haken. U. S. 2,130,210, Sept. 13, 1938 (Aug. 7, 1935).

Separation from liquids of solids or other liquids. J. Bibby & Sons, Ltd., Sturtevant Engineering Co., Ltd., A. Ibison, and H. W. Wagner. Brit. 494,153, Nov. 2, 1938 (April 16, 1937).

Kilns, Furnaces, Fuels, and Combustion

Calculation of heats of combustion of solid and liquid fuels from the heat values of their components. R. Michel. *Feuerungstechnik*, **26**, 274–78 (1938).—M. gives many examples of this type of calculation, particularly with reference to coals. A general value for the heat value of carbon in coals is deduced to be 95 to 102 Cal. E.P.

Chemical constitution of a bituminous coal as revealed by its hydrogenation products. Burnard S. Biggs and J. F. Weiler. *Jour. Amer. Chem. Soc.*, **59** [2] 369–72 (1937).—By catalytic hydrogenation, first over Adkins catalyst at 350°C and then over Raney nickel catalyst at 220°C, approximately 80% of the carbon of the extract and of the residue from the benzene extraction of a Pittsburgh seam coal at 260°C has been converted to hydroaromatic oils which may be regarded as the hydrocarbon skeletons of the building units in the respective materials. Fractionation of these oils followed by characterization of the fractions through their molecular weights, boiling points, refractive indices, and hydrogen-carbon ratios has given an approximate distribution of the various sized units in the extract and in the residue. F.G.H.

Coal consumption in the brick industry. S. Fujita. *Jour. Fuel Soc. Japan*, **16** [176, Sect. 1] 373–81 (1937); in English, *ibid.*, [176, Sect. 2] 46–47.—F. studied the fuel problems of the firebrick industry; he discusses (*a*) fuel consumption in the firebrick industry of Japan, (*b*) type of kiln and its efficiency, (*c*) fuel problems of the future, (*d*) saving of fuel, (*e*) utilization of insulating brick, and (*f*) utilization of low-grade coal. In 1936, 730,000 tons of fire brick were produced in Japan. Most of the fuel used was lump coal (about 80%), and its consumption is about 300,000 tons per year. The second-grade coal of Chikuho (volatile matter 35.1, fixed carbon 43.02, and ash 19.93%, about 6350 cal.) is used for firing fireclay brick, and first-grade Chikuho coal (volatile matter 33.94, fixed carbon 44.47, and ash 14.8%, about 6820 cal.) is used for silica brick. Ring, downdraft, and tunnel kilns are generally used. Their thermal efficiencies are as follows: ring 50, downdraft 15 to 25, and tunnel 60 to 65%. The tunnel kiln is the best from the standpoint of thermal efficiency, but it has disadvantages of higher cost of construction and larger units of production. The tunnel kiln saves about 60% of the fuel used with the periodic kiln. To reduce fuel consumption and increase heat efficiency, the stoker and insulating brick are suggested. Low-grade coal can be used as producer gas for firing fire brick. Y.K.

Combination oil and gas burners. O. F. Campbell. *Refiner & Natural Gasoline Mfr.*, **17** [7] 315–24 (1938).—C. discusses fundamental theories of combustion and points out that the fuel-burning rates per cubic foot of furnace volume are a function of the effective mixing of fuel and

air by the burner. The fuel burner, therefore, is the more important factor, as far as heat release per cubic foot of furnace volume is concerned. The most essential factors in the successful burning of any fuel are time, temperature, and turbulence. C. gives numerous charts and tabulated data on gases and oils used as fuels and discusses in detail representative types of industrial combination oil and gas burners. J.J.H.

Design and firing of kilns: VI. ANON. *Brit. Clayworker*, **47** [555] 108–10 (1938).—A modern German Hoffman kiln and a method of setting the ware are described. **VII.** *Ibid.*, [556] 144–46.—The lighting up of a Hoffman kiln and the advance heating of newly set chambers are discussed. **VIII, Study and record of kilns.** *Ibid.*, [557] 174–77; [558] 204–206.—The heating up and firing of a Hoffman kiln, the effect of weather variation on firing, and the use of gages and instruments during operation are discussed. For Part V see *Ceram. Abs.*, **17** [10] 336 (1938). R.A.H.

Determination of temperature distribution in solid bodies. W. TRINKS. *Ind. Heating*, **5** [10] 901–904 (1938).—T. discusses a set of German tables on the cooling processes of simple bodies which simplify the determination of the temperature distribution in solids. The method applies not only to the charge of steel, etc., in the heating chamber but also to the furnace walls. Examples show the practical application of some of the curves. M.H.

Electric furnace in ceramics. H. MEUCHE AND R. HUGOT. *Verre & Silicates Ind.*, **9** [17] 194–99 (1938).—Several types of resistance furnaces used in ceramics are described: (1) Muffle kilns for firing or glazing ceramic art pottery or firing decorations on porcelain or glass can be charged during the day and adjusted to turn on automatically at night when reduced night rates for electricity begin. The current also shuts off automatically when the firing is finished. Chrome-nickel alloys, distributed over the walls of the kiln, are used for resistances. (2) Tunnel kilns are used for firing decorations on porcelain at 950° maximum. The objects to be fired are placed in heat-resistant wire baskets and are rolled through the kiln. Temperature is regulated automatically. The three zones of the kiln are for preheating, firing at high temperature, and cooling; oxidizing medium is assured. A kiln 14 m. in length was installed at the Langenthal Porcelain Factory in 1927 and has been in operation since without interruption. (3) "Passage" kilns fired with electricity maintain the desired temperatures in the different canals. In this type, which is used mostly for the treatment of faience tile, saggers are not needed; the tile is propelled individually through the firing canals. The temperature is regulated automatically and is homogeneous in each canal. Operation lasts for 6 to 8 hr. instead of 50 and 60 hr. for round and tunnel kilns. (4) Electric tunnel kilns for large-scale production must function continuously, and although few have been built, this type is more advantageous than all types of furnaces fired with other fuels. Two tunnel kilns in operation abroad are described. (5) The first electric double tunnel kiln for firing hard porcelain was installed at the Langenthal Porcelain Factory in May, 1937 (see "Firing—," this page). Automatic production of the temperature curve for firing and the different conditions of atmosphere as a function of the temperature curve were perfected. When the unglazed porcelain emerges from the end of the tunnel into the enameling room, time and handling are saved by immediate enameling and introduction into the second tunnel. Electric furnaces result in a great regularity of the quality of the ware with a minimum of waste and less dependence on the skill of the personnel; fewer workmen are needed. Illustrated. M.V.C.

Electric furnaces with controlled atmospheres in the United States. J. EBERWEIN. *Stahl & Eisen*, **57**, 945–49 (1937).—E. describes bell-type and through-type electric furnaces used in the U. S. for bright annealing steel ribbon and wire in atmospheres of cracked ammonia, natural, coke-oven, or illuminating gas, or their products of partial combustion. In one installation ammonia is catalytically cracked at atmospheric pressure at 550° to 600°C and passed into a bell-type furnace which is raised to 750°C held for 8 hr., and cooled in 20 to 25 hr. In another installation the hydrogen is burned from cracked ammonia in controlled quantities of air, giving largely hydrogen or largely nitrogen. Water vapor is removed by cooling and by activated alumina. For through-type furnaces, natural gas is burned with air over nichrome catalysts, oxygen is removed by heated copper gauze, and water is removed as above. A successful atmosphere is 13 CO, 4 CO_2, 24 H_2, 3 CH_4, and 56% N_2. Burned coke-oven gas from which oxygen, sulfur, and water are removed is used in another installation. Bright annealing is shown to be more economical than pickling. L.R.B.

Firing hard porcelain in an electric furnace. M. D. *Argile*, No. 183, pp. 3–5 (1938).—When the electric double tunnel kiln for firing hard porcelain was put in operation at Langenthal (Switzerland) in 1937, it marked a turning point in the history of the industry. Millions of francs were required for its construction. Its capacity of production is 3.5 tons of raw porcelain in 54 to 56 hr. The heating elements are interchangeable silicon carbide rods which show satisfactory durability. The total power of the furnace is 530 kw. M.V.C.

Heat control through proper insulation. R. C. PARLETT. *Refiner & Natural Gasoline Mfr.*, **17** [4] 152–57 (1938).—P. discusses the use of insulation in the oil industry. Insulations used on heated surfaces are grouped according to their form, *e.g.*, (1) molded, (2) laminated asbestos felt, (3) felted mineral fiber, (4) brick, and (5) plastic. Brief characteristics of each type, applications, and the limitations of various materials are discussed. The selection of proper thickness for insulation and the method of application are as important as the type of material selected. J.J.H.

Heats of combustion of anthracite cokes and of artificial and natural graphites. PHILLIP H. DEWEY AND D. ROBERTS HARPER, 3D. *Jour. Research Nat. Bur. Standards*, **21** [4] 457–74 (1938); R.P. 1139. Price 5¢.—The heats of combustion of 30 samples of anthracite coke of known different temperatures of preparation (900° to 1300°C), hydrogen contents, and adsorptive capacities were determined in order to study the effect of these properties on the energy content of the material. Data were also obtained on the heats of combustion of two samples of pure, ash-free, artificial graphite and four samples of natural graphite. The heats evolved (expressed in international kilojoules) for the combustion of 1 mole of solid carbon to form CO_2, at 25.0°C and a pressure of 1 atm., without the production of external work, are as follows: artificial graphite (grade 1) No. 0, 393.39 ± 0.17; artificial graphite (grade 2) No. 1, 393.25 ± 0.15; Ticonderoga natural graphite, 393.32 ± 0.11; Buckingham natural graphite, 393.35 ± 0.13; Baffin Island natural graphite, 393.37 ± 0.26; and hydrogen-free anthracite coke, 403.03 ± 0.29. R.A.H.

How much electric heat. W. G. MEROWIT. *Factory Management & Maintenance*, **96** [9] 78–80, 118, 120 (1938).—M. outlines the principles and formulas needed in calculating the wattage required in typical electric heating applications. Sample calculations are given, and several common types of electric heating elements are illustrated. J.L.G.

Influence of moisture on the intensity of the visible radiation of the flame of CO and O_2. E. KONDRAT'EVA AND V. KONDRAT'EV. *Acta Physicochim. U.R.S.S.*, **8** [4] 481–90 (1938).—The light yield in the visible spectrum of the flame of $2CO + O_2$ was measured as a function of the proportion of water vapor present in the reaction mixture. The light yield decreased rapidly with increase in partial pressure of water vapor. E.P.

Long and short gas flames in industrial heating. A. M. CAPPER. *Ind. Heating*, **5** [9] 790–98, 836 (1938).—C. discusses the relative merits of long and short flames (more appropriately called "luminous" and "clear" flames). A better rate of heat transfer and more uniform temperatures are obtainable with the long, luminous flames. Burner and furnace arrangement for their utilization is described. M.H.

Oxidation of a Pittsburgh seam bituminous coal and

low-temperature coke by alkaline permanganate. B. JUETTNER, R. C. SMITH, AND H. C. HOWARD. *Jour. Amer. Chem. Soc.*, **59** [2] 236–41 (1937). F.G.H.

Successful firing of carbonaceous materials. CHARLES HILL. *Brit. Clayworker*, **47** [557] 192–93 (1938).—The necessity of having properly trained men to operate kilns firing carbonaceous clayware, the desirability of fan draft, and the proper setting and drying of the ware are discussed. R.A.H.

Temperature and heat transmission in the heating chamber of industrial furnaces. H. SCHWIEDESSEN. *Arch. Eisenhüttenwesen*, **11** [8] 363–74; [9] 431–42 (1938).—The relation between factors affecting the heat balance of heating chambers is expressed in a set of formulas. The relation between wall temperatures and the total heat transfer is affected chiefly by the average temperature in the heating space, density of the smoke layer, state of the wall surface, wall losses, and the difference in temperature between the wall and goods to be heated. The last two factors have a comparatively slight influence, and the general application of the formulas is greatly handicapped by the lack of means for accurate determination of the density of the smoke layer. Examples of practical application of the formulas are included. J.D.G.

Temperature uniformity in combustion chambers. M. H. MAWHINNEY. *Ind. Heating*, **5** [10] 906–13 (1938).—M. discusses the factors involved in producing uniform temperature distribution in a combustion chamber, particularly the shape of the chamber and port distribution. Results are summarized, and definite rules are developed. See "Combustion—," *Ceram. Abs.*, **16** [1] 35 (1937). M.H.

Tunnel kiln in the ceramic industry. E. DAMOUR. *Compt. Rend. 17th Congr. Chim. Ind.*, **1937**, 1000–12; *Brit. Chem. & Phys. Abs.–B*, **57** [7] 784 (1938).—Calculations are made of the fuel and air consumptions required to reach a given temperature when heating materials which (1) are thermally inert (SiO_2 and MgO brick), (2) undergo endothermic reactions (clay products), and (3) are further worked on at high temperature, thereby losing the heat which is not recoverable (metal reheating).

Tunnel kiln firing: II, Choosing a tunnel kiln for pottery firing. NORMAN WILSON. *Trans. Ceram. Soc.*, **37** [7] 255–78 (1938).—Pointing out the shortcomings of the round intermittent type of kiln, W. discusses the advantages of the tunnel kiln for pottery firing, direct firing *vs.* muffle firing, and saggers *vs.* open firing in regard to quality and cost of ware. The advantages and disadvantages of circular and straight tunnel kilns are listed. **III, Difficulties in tunnel kiln practice.** L. BULLIN. *Ibid.*, [8] 313–45.—If town gas is not available as fuel for kiln firing, B. suggests a pressure gas producer using anthracite coal or coke as a substitute. The necessity of controlling the firing curve to obtain the minimum of spoiled ware and the setting in the kiln to obtain temperature uniformity are discussed. For Part I see *Ceram. Abs.*, **17** [11] 362 (1938). R.A.H.

BOOKS AND SEPARATE PUBLICATIONS

Ball-mill grindability indexes of some American coals. H. F. YANCEY AND M. R. GEER. *U. S. Bur. Mines Repts. Investigations*, No. 3409, 9 pp. Free. R.A.H.

Coal-mine fans and coal-mine ventilation. D. HARRINGTON AND E. H. DENNY. *U. S. Bur. Mines Information Circ.*, No. 7032, 20 pp. Free. Federal and state ventilation laws are reviewed, and reasons for some of their provisions are given; 32 recommendations for safe ventilating practice are included. R.A.H.

Oxidation of anthracite. Effect of time of contact on concentration of oxygen in the effluent gases. G. S. SCOTT AND G. W. JONES. *U. S. Bur. Mines Repts. Investigations*, No. 3405, 7 pp. Free. See *Ceram. Abs.*, **16** [4] 127 (1937). R.A.H.

Sampling and analysis of coal. A. C. FIELDNER AND W. A. SELVIG. *U. S. Bur. Mines Tech. Paper*, No. 586, 48 pp. Supt. of Documents, Govt. Printing Office, Washington, D. C. Price 10¢. These notes apply particularly to coal in place in a mine or outcrop and supplement information already published by the Geological Survey and the Bureau of Mines. R.A.H.

PATENTS

Continuous kiln. ARTHUR GEYER. U. S. 2,131,418, Sept. 27, 1938 (March 10, 1937).

Tunnel kiln. F. A. PHILO (General Tile Corp. and Mosaic Tile Co.). U. S. 2,132,831, Oct. 11, 1938 (July 16, 1936). A tunnel kiln embodying, in combination, a muffle, means for passing ware therethrough, a U-shaped heat-applying flue area comprising a horizontal base portion having passages in contact with the muffle bottom, opposite vertical branch portions having passages in contact with the sides of the muffle, and separate top horizontal portions in contact with the top of the muffle, the passages in the branch portions extending in a direction oblique to the middle line of the muffle sides, and means for supplying heat to the flue area.

Tunnel kiln and method of operating. G. D. PHILLIPS. Brit. 491,076, Sept. 7, 1938 (Feb. 22, 1937).

Tunnel ovens. J. WEDGWOOD & SONS, LTD., AND N. WILSON. Brit. 493,743, Oct. 26, 1938 (Feb. 14, 1938).

Geology

Andalusite and sillimanite in uncontaminated igneous rocks. EDWIN S. HILLS. *Geol. Mag.*, **75**, 296–304 (1938).—The orthodox view is that these minerals in unaltered igneous rocks are due to the assimilation of shales, etc. H. lists some rocks in which it has been suggested that assimilation has not been responsible. There are 13 granites (nine of the two-mica type) carrying andalusite, two muscovite-granites with sillimanite, six aplites carrying one or the other, one greisen, and several pegmatites. The occurrence of muscovite in some rocks may show excess alumina present in the rock, which may be the source of the andalusite and sillimanite. W.D.F.

Base status of Scottish soils: I, Effects of lime on five typical soils from northeast Scotland. R. L. MITCHELL. *Jour. Agr. Sci.*, **26** [4] 664–78 (1936).—Mechanical and ultimate chemical analyses and p_H, exchangeable-cation, and lime-requirement determinations were made on five typical soils before lime applications and at two 6-month intervals thereafter. Maximum lime effect occurs, in some cases, within 6 months. In other cases, neutralization continues during the second 6 months; p_H changes vary according to soil type. Exchangeable-cation determinations show that, in four soils, 50% of the applied calcium had entered the exchange complex; in the other, 70% had entered. M. discusses the results in connection with the various soil types. Illustrated. P.S.D.

Black barite deposits in upper east Tennessee. R. A. LAURENCE. *Jour. Tenn. Acad. Sci.*, **13** [3] 192–97 (1938).—Deposits of black barite in upper east Tennessee are described. The chief properties of the mineral are given, and representative analyses are listed. The exceptional purity of these deposits is of special commercial interest, but their limited extent and scattered nature precludes any large-scale development. See "Concentration tests—," *Ceram. Abs.*, **17** [6] 230 (1938). H.T.

Bleaching clay: X. RAFAEL FUSSTEIG. *Petroleum Engr.*, **9** [9] 72–74 (1938).—F. describes and discusses the merits of processes for reactivating spent bleaching clay. For Part VIII see *Ceram. Abs.*, **17** [10] 338 (1938). P.G.H.

Canadian bentonites. WILFRED GALLAY. *Can. Jour. Research*, **16B** [1] 6–34 (1938).—Canadian bentonites were investigated as refining and bleaching agents for industrially important petroleum and fatty acids. Canadian clays were chiefly from the four western provinces, and comparisons are shown with results obtained on

several imported clays now in use. Several Canadian bentonites show good results in the bleaching of fatty oils and petroleum distillates. Bentonite from the Morden (Manitoba) district possesses unusually high adsorbent power, and in the activated condition its effect on all the raw materials tested is much superior, within the limits of the laboratory test methods employed, to that of all other bentonites examined. Optimum methods of activation of these bentonites are discussed. Low silica to alumina ratio and high percentage of combined water are the outstanding characteristics of Morden bentonite in comparison with adsorbent clays from other sources. Bentonites were not found suitable for use in the vapor phase percolation treatment of cracked distillates. E.J.V.

Clays of decalcification. M. DÉRIBÉRÉ. *Argile*, No. 185, p. 5 (1938).—Deposits of clay of decalcification in caves or subterranean caverns are generally much purer and more plastic than those where the alteration has taken place on the surface; they can be used in the brick industry. M.V.C.

Complex production of aluminum oxide, soda, and Portland cement from nepheline. A. S. BOLDYREV. *Tsement*, **5** [3] 19–23 (1938).—B. describes a projected plant. P.B. & E.S.

Composition and structure of soil organomineral gels and soil fertility. A. T. TYULIN. *Soil Sci.*, **45** [5] 343–57 (1938).—T. describes a method of fractional peptization and fractional coagulation for determining the organomineral gels in soil. 43 references. G.R.S.

Crystal morphology from the standpoint of structure theory. WILLI KLEBER. *Fortschr. Mineral., Krist., & Petrog.*, **21** [2] 169–224 (1937).—K. attempts to represent the relation between structure and morphology of crystals while contrasting the existing theories for such a relation. Laves' theory of the system in the structural joints of the crystals will probably be of special importance for future morphological researches. A basic advance seems to lie in the compilation and correlation of recent results in the theory of structure and morphology. 147 references. E.W.S.

Decomposition of minerals with hot acid vapors. R. MÜLLER WITH GERSCHBACHER, HARANT, KERMAUER, AND WAGNER. *Z. Elektrochem.*, **43** [8] 540 (1937).—Magnesite can be dissolved rapidly by passing a mixture of HCl and H_2O vapors, heated to 120° to 300°, up a tower down which the mineral is fed. The HCl and products carried forward by the vapor are absorbed completely in the cooler upper regions of the tower, and the more dilute solutions from this region are concentrated during descent. Owing to the high HCl content in the vapors, the $MgCl_2$ is not hydrolyzed. Concentrated neutral solutions are obtained, and evaporation costs are saved. This process is suitable for continuous operation. Phosphate rock can be dissolved in the same manner by the use of HCl or HNO_3. E.J.V.

Feldspar equilibrium. TOM F. W. BARTH. *Norsk Geol. Tids.*, **17,** 177 (1937); abstracted in *Chem. Zentr.*, **1938, II,** 1199.—On the basis of theoretical assumptions and experimental studies of the system orthoclase–albite–anorthite, B. concludes that all natural magmatic rock residues contain alkali feldspar with about 40% orthoclase. M.V.C.

Formation of structure in soil: IV, Structure of mixed clay-sand and clay-humus formations. D. I. SIDERI. *Soil Sci.*, **46** [2] 129–37 (1938).—The elimination of iron and aluminum oxides from the surface of clay particles increases their ability to aggregate. A particular "rod" structure arises, the "rods" being optically homogeneous and possessing positive double refraction. For Parts **I–III** see *Ceram. Abs.*, **16** [4] 130 (1937). G.R.S.

Glassmaking sands of Bargarh. M. L. MISRA. *Science & Culture*, **3** [10] 558–61 (1938).—M. presents a field study of the sandstone beds occurring near Bargarh (30 miles from Allahabad), the chief sources of supply of glass sands to all glass factories in northern India, with their chemical composition and microscopic characteristics. They are of three grades: (1) white, (2) dirty white, and (3) yellowish; representative analyses are given which confirm the field observation. The best sands contain about 98% SiO_2 and 0.05% Fe_2O_3. This grade, however, does not reach the glass factories. They receive sands with about 97% SiO_2 and Fe_2O_3 varying from 0.1 to 0.5% (grades 2 and 3). M. concludes from microexamination and chemical analyses that, owing to differential subaërial weathering of the compact sandstone, its ferruginous cementing material has been leached out by surface waters, leaving behind incoherent and loose masses of sand at places where conditions for weathering were more favorable. The presence of a higher percentage of iron in some cases is attributed to deposition of iron on sand grains after evaporation of the ferruginous waters. According to M., if grade 1 sand is not adulterated and a proper sorting is made in the field, best quality sand can be obtained from Bargarh from which the finest quality glass can be produced. By proper washing, grades 2 and 3 can also be considerably improved. A.P.S.

Grain-size factor in the classification of igneous rocks. A. KINGSLEY WELLS. *Geol. Mag.*, **75,** 417–22 (1938).—W. favors the classifying of rocks according to grain size and mineral composition rather than mode of occurrence and mineral composition. The zoölogist has the same name for an animal wherever it occurs, but many petrologists will call nearly identical, medium-grained, plagioclase-pyroxene rocks a dolerite in a thin sheet of rock, a gabbro in a deep-seated mass, or a basalt in a lava flow. W.D.F.

Grain size of whiteware clays as determined by the Andreasen pipette. GEORGE A. LOOMIS. *Jour. Amer. Ceram. Soc.*, **21** [11] 393–99 (1938).

Greek bauxite and its decomposition. ANT. A. DELYANNIS. *Metall & Erz*, **34,** 282–87 (1937); *Chem. Abs.*, **31,** 6585 (1937).—Greek bauxite has the following composition: SiO_2 1.5 to 3.5, Fe_2O_3 20 to 25, TiO_2 2.5 to 3.5, H_2O 11.0 to 13.0, and Al_2O_3 56 to 62%. An important constituent of bauxite obtained from Grawia is gallium (272 g./ton). Treatment of the Greek ores by ignition with Na_2CO_3 and NaOH under pressure produced satisfactory decomposition. See "Crystalline—," *Ceram. Abs.*, **17** [11] 363 (1938).

Hydrothermal reactions: I, Formation of magnesium hydrosilicates. W. JANDER AND J. WUHRER. *Z. Anorg. & Allgem. Chem.*, **235,** 273–94 (1938).—Talc and serpentine were synthesized from their oxides at temperatures below the critical point of water. The hydrothermal transformations of natural and synthetic silicates and metasilicates of magnesium were investigated in acid, neutral, and alkaline solutions. E.P.

Improved technique in grading of coarse and fine sands during mechanical analysis of soils. B. E. BEATER. *Jour. Agr. Sci.*, **27** [1] 123–25 (1937).—Attention is drawn to a source of error arising when determining coarse and fine sand fractions of soils by the revised official method of the Agricultural Education Assn. (*Agr. Progress*, **5,** 137 (1928)), in which the dispersed soil is washed on a No. 70 I.M.M. sieve with hot water and rubbed gently with a rubber pestle until no more passes through. Dry sieving will insure more correct separation without involving a great amount of extra work. P.S.D.

Inderite and the rock surrounding it. ANNA M. BOLDYREVA. *Zapiski Vserossiĭskogo Mineral. Obshchestva*, **66,** 651–72 (1937); abstracted in *Chem. Zentr.*, **1938, II,** 1020.—The composition of inderite studied corresponds to the formula $2MgO \cdot 3B_2O_3 \cdot 15H_2O$. Its heating curve and structure are similar to those of the Ca mineral inyoite ($2CaO \cdot 2B_2O_3 \cdot 13H_2O$). The accompanying rocks are quartz, calcite, and basic hydrated $MgCO_3$. M.V.C.

Isohydric p_H value of soils and its determination. A. N. PURI AND A. SARUP. *Soil Sci.*, **46** [1] 49–56 (1938).—Isohydric p_H value of a soil is defined as the p_H value of a buffer solution which shows no change in reaction on coming into contact with the soil and which consequently brings about no change in the base content of the soil. A method for determining isohydric p_H value, titration curve, buffer capacity, and lime requirement of soils is described. G.R.S.

Laterites of western Samoa. F. T. SEELYE, L. I. GRANGE, AND L. H. DAVIS. *Soil Sci.*, **46** [1] 23–31 (1938).—The soil process involved in the formation of immature laterite in the tropics and the practical problem of the recognition of the stage to which the lateritic process has proceeded are discussed. G.R.S.

Mineral deposits of the U.S.S.R. TOM EDWARDS. *Mining Mag.*, **58**, 265–79, 335–43 (1938).—The main deposits of bauxite are in the Tikhvin district. In 1934, production was 60,000 tons, and first-grade reserves amounted to 373,000 tons. Chromite is found in the Urals, with production of 217,000 tons in 1935 and reserves of 7,000,000 tons. Magnesite is found principally at Satka, with a production of 900,000 tons in 1936. Apatite occurs in the Khibina mountains. Chrysotile asbestos is found at Bazenbov, and 100,000 tons were produced in 1935. Other nonmetallics are graphite, mica, barite, fluorite, talc, and sulfur. Deposits of gold, copper, lead, zinc, manganese, nickel, tin, tungsten, iron, coal, and petroleum are also described. W.D.F.

Mineralogical character of the aluminum hydroxides in the bauxites of French West Africa. J. DE LAPPARENT AND R. HOCART. *Compt. Rend.*, **207** [3] 202–203 (1938).—Rich deposits of Al hydroxide not chemically bound to silica, hydrargillite, or gibbsite ($Al(OH)_3$) and containing boehmite in moderate quantity are described with regard to geographical and geological conditions. M.H.

Minerals used in the ceramic industry. NORMAN B. DAVIS. *Trans. Can. Inst. Mining & Met.*, **41** (in *Can. Mining & Met. Bull.*, No. 315), 276–82 (1938).—D. discusses ceramic uses of and Canadian plants handling clay, quartz, feldspar, limestone, gypsum, magnesite, talc, salt, diatomite, and barite. A.H.E.

Nonmetallic minerals of New Brunswick with special reference to diatomite. W. E. MCMULLEN AND W. J. WRIGHT. *Can. Mining & Met. Bull.*, No. 316, pp. 373–84 (1938).—Coal, oil, gas, limestone, lime, granite, sandstone, slate, and much gypsum are produced in New Brunswick. Bog manganese, iron ocher, and rock salt occur in the province. Details are given on several diatomite deposits. G.M.H. + A.H.E.

Origin of dolomite. V. B. TATARSKIĬ. *Zapiski Vserossiĭskogo Mineral. Obshchestva*, **66**, 677–84 (1937); abstracted in *Chem. Zentr.*, **1938, II**, 1019. M.V.C.

Petrographic study of melting products of apatite nepheline rocks from Khibina. T. M. DEMBO. *Zapiski Vserossiĭskogo Mineral. Obshchestva*, **66**, 517–22 (1937); abstracted in *Chem. Zentr.*, **1938, II**, 1020.—The rock studied begins to melt at 1000°; at 1300° it is all melted except apatite. The melted mass forms a brown, green, or colorless glass on cooling. M.V.C.

Petrography of clays. CARL W. CORRENS. *Naturwissenschaften*, **24**, 117–24 (1936); *Chem. Abs.*, **30**, 4437 (1936).—C. discusses the grain-size distribution, microscopic and X-ray structure, chemical qualities, and applications of clays. Many analyses and tabulated data are given. See "Investigation—," *Ceram. Abs.*, **16** [11] 350 (1937).

Physical chemistry of clay. R. K. SCHOFIELD. *Brit. Clayworker*, **47** [558] 208–10 (1938).—S. reviews briefly the crystal structure of clays. R.A.H.

Polishing apparatus for ore minerals. JOSEPH MURDOCH. *Econ. Geol.*, **33** [5] 542–53 (1938).—M. describes an apparatus for mounting mineral specimens in Bakelite and an apparatus for polishing them by Vanderwitt's method. The process is slower than the usual methods but produces superior sections for microscopic examination with very low relief between the hard and soft minerals of the section. This permits the use of high magnifications and the observation of extremely minute structures and relationships undistorted and unharmed. Illustrated. J.L.G.

Pore size and internal volume of amorphous and crystalline materials. G. GRAUE AND N. RIEHL. *Z. Anorg. & Allgem. Chem.*, **233** [4] 365–75 (1937).—The pore structure of different materials was studied by a method based on the use of emanation from radioactive gases. Gases present in the interior of solid bodies are able to penetrate not only through macropores but also through pores of only atomic dimensions. E.P.

Production of raw materials and improvement of clay. OTTO MANFRED. *Argile*, No. 185, pp. 17–19 (1938).—The improvement in the resistance of clay and other related building products by compression molding is shown. M.V.C.

Pyrochemical properties of pyrophyllite. C. W. PARMELEE AND L. R. BARRETT. *Jour. Amer. Ceram. Soc.*, **21** [11] 388–93 (1938).

Pyrometric properties of spodumene-feldspar mixtures. J. E. BOYD, JR. *Jour. Amer. Ceram. Soc.*, **21** [11] 385–88 (1938).

Refractory clays. R. LEDUC. *Argile*, No. 185, p. 19 (1938).—An analysis of refractory clays of different localities in France is tabulated. See *Ceram. Abs.*, **17** [7] 262 (1938). M.V.C.

Shape-sorting of sand grains by wind action. G. R. MACCARTHY AND J. W. HUDDLE. *Amer. Jour. Sci.*, **35**, 64–73 (1938).—The superior roundness of eolian sands compared to other varieties is due to a process of sorting. Experiments show that wind transports the grains chiefly by saltation; this method favors rounded grains. J.B.A.

Shearing experiments on selected minerals and mineral combinations. ESPER S. LARSEN AND P. W. BRIDGMAN. *Amer. Jour. Sci.*, **36**, 81–94 (1938).—The effect of drastic shearing at room temperature and a mean confining pressure of 50,000 kg./cm.^{2} was studied. Attempts to form "Stress-minerals" were unsuccessful, but a great many changes were observed. In all cases the crystal structure was highly broken down, and in many cases the product appeared to be a transparent isotropic glass whose index of refraction was less than that of the original mineral. X-ray examination gave no positive evidence that these were glassy phases. Some of the detailed changes were as follows: Cristobalite transformed to a new form of silica with a higher index. Opal was dehydrated and in one case turned to quartz. Four pyroxenes gave a substance of much lower index, possibly an amphibole. Azurite gave a substance of different chemical properties. Gypsum lost water. Siderite turned red and was probably converted to an oxide or hydroxide. J.B.A.

Silicate clay materials. W. V. ENGELHARDT. *Fortschr. Mineral., Krist., & Petrog.*, **21** [2] 277–340 (1937).—E. describes and discusses the occurrence, dehydration, optical properties, and chemical composition of kaolinite, anauxite, dickite, nacrite, halloysite, metahalloysite, montmorillonite, beidellite, and nontronite. 123 references. E.W.S.

Silicate materials in the chemical industry. P. P. BUDNIKOV AND M. I. NEKRICH. *Zhur. Priklad. Khim.*, **11**, 151–75 (1938).—A review and a large bibliography are presented. P.B. & E.S.

So-called "melting temperatures" of some minerals. D. P. GRIGOR'EV. *Zapiski Vserossiĭskogo Mineral. Obshchestva*, **66**, 673–76 (1937); abstracted in *Chem. Zentr.*, **1938, II**, 1018.—The refractoriness of minerals such as tremolite, serpentine, talc, and kaolin given in text books is in reality not refractoriness, since these minerals disintegrate on heating and form new systems with different solid phases. M.V.C.

Thermal expansion of some clay minerals. J. F. HYSLOP AND A. MCMURDO. *Trans. Ceram. Soc.*, **37** [5] 180–82 (1938). **Discussion.** F. H. CLEWS AND J. H. CHESTERS. *Ibid.*, p. 182; see *Ceram. Abs.*, **17** [4] 158 (1938). R.A.H.

BOOKS AND SEPARATE PUBLICATIONS

Experimental results and methods of obtaining kaolinite from eastern Washington clays for the production of aluminum metal. JOSEPH C. KIEFFER. *Wash. State Coll., State Electromet. Research Labs. Bull.*, **K**, 25 pp. (1936).—Purification of kaolin in clay by flotation does not seem to be feasible, and washing (elutriation) is recommended as a more satisfactory method. The resulting kaolinite would prove satisfactory for use in the ceramic industry or as a source of aluminum. A.G.S.

Introduction to Geology. A. E. TRUEMAN. Thomas Murby & Co., London, 1938. 251 pp., 133 figs. Price 4s net, cloth. Reviewed in *Bull. Amer. Assn. Petroleum Geologists*, 22 [9] 1288 (1938). G.M.H.

Physical properties of typical American rocks. JOHN H. GRIFFITH. *Iowa State Coll. Agr. Mech. Arts, Eng. Expt. Sta. Bull.*, No. 131, 56 pp. (1937).—G. gives the scleroscope hardness, thermal expansion coefficient, compressive strength, true and apparent specific gravities, weight per cubic foot, absorption, percentage of pores, and percentage of solids of 97 rocks, including igneous, sedimentary, and metamorphic, of a wide range of composition. These data are analyzed mathematically, and graphs are drawn, plotting absorption against compressive strength for these rocks, other rocks, tile, and brick; absorption against modulus of rupture, scleroscope hardness, specific weight, and percentage of solids; and scleroscope hardness against compressive strength. The compressive strength and absorption are related by the equation $p\,(A + 4) = 80{,}000$, where p = compressive strength (lb./sq. in.) and A = absorption of water by weight (%). One half of the results were within the limit $p\,(A + 4) = 80{,}000\ (1 \pm 0.25)$. W.D.F.

Selective mining of clay. H. E. NOLD. *Amer. Refrac. Inst. Tech. Bull.*, No. 72, 4 pp. (Oct., 1938); see *Ceram. Abs.*, **17** [3] 123 (1938). H.E.S.

PATENTS

Drilling mud. CLIFFORD P. BOWIE. Can. 376,642, Sept. 20, 1938 (Nov. 30, 1936; in U. S., Dec. 3, 1935). G.M.H.

Drilling mud. HAROLD T. BYCK AND ALBERT G. LOOMIS (Shell Development Co.). Can. 377,027, Oct. 11, 1938 (Sept. 17, 1937; in U. S., Sept. 29, 1936). Can. 377,028, Oct. 11, 1938 (Sept. 17, 1937; in U. S., Sept. 23, 1936). G.M.H.

Sand-conditioning apparatus. STANLEY B. DAVIES (Royer Foundry & Machine Co.). Can. 375,819, Aug. 16, 1938 (Feb. 19, 1937; in U. S., Dec. 17 and Dec. 24, 1936). G.M.H.

Chemistry and Physics

Accurate wet-combustion method for determination of carbon in soils. PAULINE ALPER. *Jour. Agr. Sci.*, 28 [2] 187–96 (1938).—The apparatus and method are described. Results of experiments with pure organic compounds, coal samples, and soil samples are given. Previous inaccurate results have probably been due to (*a*) incomplete oxidation of carbon and (*b*) incomplete absorption of carbon dioxide. This method ensures complete oxidation and complete absorption. P.S.D.

Apparatus for electrometric titrations of high precision. EINAR STENHAGEN. *Ind. Eng. Chem., Anal. Ed.*, 10 [8] 432–33 (1938).—Illustrated. F.G.H.

Cadmium: collected references in microchemistry. H. HILLER AND F. MACHEK. *Mikrochemie*, 19, 147–61 (1936).—Methods for the determination of cadmium published since 1926 are reviewed. 110 references. L.E.T.

Calculation of the rate of fall of dust particles. T. WIDELL. *Z. Ver. Deut. Ing.*, 80 [50] 1497–98 (1936).—A formula is developed for the rate of fall of spherical bodies larger than 50 μ in diameter where the Reynolds number is >1. A curve for the coefficients is appended. M.H.

Chemical nature of clays. K. ENDELL AND U. HOFMANN. *Proc. Internat. Conf. Soil Mech. & Foundation Eng.*, 1, 51–54 (1936); *Chem. Abs.*, 32, 6412 (1938).—The S value (sum of the exchangeably bound cations) is determined in milliequivalents per 100 g. of dry material by means of replacement with NH_4Cl. The values of this characteristic of clays consisting largely of certain of the clay minerals lie between 3 and 15 me. for kaolin (kaolin clays), 40 and 100 me. for bentonite (montmorillonite clays), and 20 and 50 me. for unknown clay minerals. Univalent ions in clays are highly dissociated and can hold large quantities of H_2O; bivalent ions are more firmly attached to the clay particles, but can hold a certain amount of H_2O; slightly dissociated (H) and trivalent cations can hold very little H_2O. The individual layers of the space lattice of montmorillonite can increase or decrease their distance from one another, as H_2O enters the crystal. The thixotropic properties of clays probably partially explain the fact that many soils have a smaller bearing capacity in a disturbed than in an undisturbed state. Disintegration of clay in H_2O becomes more marked with increasing amounts of exchangeable bases. The plastic flow of clay can be prevented by the destruction of the swelling capacity of clay in water; this might be accomplished by an electric current. See "Relations—," *Ceram. Abs.*, 14 [6] 152 (1935).

Crystal structure of selenium dioxide. JAMES D. MCCULLOUGH. *Jour. Amer. Chem. Soc.*, 59 [5] 789–94 (1937).—Illustrated. F.G.H.

Crystalline boric oxide. L. MCCULLOCH. *Jour. Amer. Chem. Soc.*, 59 [12] 2650–52 (1937).—Fused boric acid, held for days at 225° to 250°C and retaining 8 to 15% water, developed crystals, giving up its water and attaining finally the state of a stony solid. By "seeding" such a liquid, this change is induced to proceed immediately. The solid is essentially anhydrous boric oxide. The X-ray picture shows it to be crystalline. Its solubility curve is given. Its melting point is 460° to 470°C, and its density is 2.42. Illustrated. F.G.H.

Detection and determination of boric acid by turmeric in strongly acid solution. HARALD SCHÄFER. *Z. Anal. Chem.*, 110 [1–2] 11–18 (1937). E.J.V.

Determination of lithium. H. GROTHE AND W. SAVELSBERG. *Z. Anal. Chem.*, 110 [3–4] 81–94 (1937).—The determination of lithium by precipitation as LiF and Li_3PO_4 is critically reviewed. Lithium is best precipitated as aluminate, which is ignited to $2Li_2O \cdot 5Al_2O_3$. The acidified lithium solution (p_H 3) is treated at room temperature with a solution of $KAl(SO_4)_2 \cdot 12H_2O$ and an excess of NaOH and brought to p_H 12.6, whereby lithium aluminate is precipitated. In determining lithium in aluminum alloys, aluminum is precipitated as $AlPO_4$ from acetic acid solution to avoid co-precipitation as with aqua ammonia. E.J.V.

Determination of the specific surface of Portland cement raw mixtures by means of the Wagner turbidimeter. T. ASANO. *Rock Products*, 39 [2] 34–36 (1936).—The Wagner turbidimeter is based on a linear relation between the surface area of particles (or concentration of suspension) and the logarithm of the intensities of the light which passes through suspensions as expressed in the equation $S_d = c\,(\log I_o - \log I_d)$, where S_d = surface area, in square centimeters, of all particles smaller than d microns in diameter; I_o = the intensity of the light, in microamperes, transmitted through clear kerosene; I_d = intensity of the light, in microamperes, transmitted through the suspension at a time interval required for a particle d microns in diameter to settle from the surface of the suspension to the center line of the light beam; and c = a constant for each cement which is called its transmittancy constant. This relation was found to hold for raw materials when a suspension of about 1 g. of raw mixture per liter of distilled water was used. Tests showed sodium silicate to be the best dispersing agent. Gradations by weight showed good agreement with air elutriation and sedimentation pipette methods. E.J.V.

Determination of the specific volumes of melts at temperatures up to 1400°. M. P. VOLAROVICH AND A. A. LEONT'EVA. *Z. Anorg. & Allgem. Chem.*, 225, 327–32 (1936).—Using a platinum dilatometer, the specific volume-temperature relationships were determined for the rocks diorite, basalt, and diabase and for the fused salts K_2SiO_3, $NaBO_2$, and $K_2B_4O_7$. At 1200° the specific volumes of the molten salts were K_2SiO_3 0.458, $NaBO_2$ 0.558, and $K_2B_4O_7$ 0.560. Thermal expansions were calculated from the density data. The expansion coefficient of

$K_2B_4O_7$ is lower than that of borax. See "Measurement—," *Ceram. Abs.*, **15** [6] 192 (1936). E.P.

Determination of zinc. A colorimetric micromethod. W. L. LOTT. *Ind. Eng. Chem., Anal. Ed.*, **10** [6] 335–38 (1938).—The method is applicable for the determination of quantities of zinc ranging from 0.05 to 1.0 mg. After a preliminary separation of the zinc from interfering elements, 5-nitroquinaldic acid is used as a precipitating agent. The precipitate is filtered from the excess reagent and converted into an orange-colored water-soluble compound by reduction with stannous chloride. The intensity of color is measured with a photoelectric colorimeter. Precipitation of zinc by 5-nitroquinaldic acid is complete within a range of p_H 2.5 to 8.0 after digestion for 30 min. Ammonium chloride and sodium chloride in concentrations greater than 0.7 *N* inhibit the complete precipitation of the zinc. The intensity of color of the reduction product of 5-nitroquinaldic acid is independent of the acid concentration at acidities lower than 0.8 *N* and of the concentration of stannous chloride. The intensity of color increases appreciably with rise in temperature of the solutions, making it necessary to carry out all readings at the same temperature. F.G.H.

Equilibria between metals, sulfides, and silicates in the melt: V, Equilibria Fe + CoO ⇌ Co + FeO and Ni + CoO ⇌ Co + NiO in the melt. W. JANDER AND A. KRIEGER. *Z. Anorg. & Allgem. Chem.*, **232**, 39–56 (1937).—In both systems the mass-action law is approximately obeyed, the equilibrium constant increasing with rising temperature according to the relation $\log K = a - b/T$. Increase in the amount of SiO_2 present increases the equilibrium constant in the Fe-CoO series but decreases it in the Ni-CoO series. Calculated heats of reaction depend on the oxygen content of the metal. For Part III see *Ceram. Abs.*, **14** [4] 101 (1935). E.P.

Examples of industrial spectrographic analyses made in the laboratory of applied spectroscopy at the University of Liège. P. SWINGS AND J. GENARD. *Rev. Universelle Mines*, **14** [4] 339–42 (1938).—The value of spectroscopic examinations of metals, mineral waters, glass, porcelain, minerals, and sands, in regard to their application in the toxicological field, is discussed with examples. E.W.S.

Experiments on the unipolar electrical conductivity of silicon carbide. M. K. CHAKRAVARTY AND S. R. KHASTGIR. *Z. Physik*, **105**, 88–91 (1937).—Crystals of silicon carbide, iron pyrites, galena, and magnetite were held by solder in brass cups, and constant electromotive forces were applied by a silver needle in contact with the crystal. The e.m.f. between this needle and a second movable needle located at different positions on the crystal was measured. Silicon carbide possessed unidirectional conductivity, but the other crystals tested did not. E.P.

Graphical representation of the mechanical analyses of soils. E. B. CAMPBELL. *Proc. Amer. Soc. Civil Engrs.*, **63**, 1861–66 (1937); *Brit. Chem. & Phys. Abs.–B*, **57** [7] 823 (1938).—An attempt is made to correlate various existing methods for the graphical representation of grain-size distribution. A semilogarithmic coördinate system is used with the grain sizes plotted as abscissas on a log scale and cumulative weight per cent values as ordinates. With curves so plotted, the grain-size distribution curves have been conventionalized by introducing straight lines. Such lines can be designated briefly by their slopes and intercepts so that data from various soils may be tabulated or plotted on drawings for purposes of comparison. The value of mechanical analysis is discussed, and recommendations are made for the nomenclature of soil fractions.

Heat content and heat capacity of slags of the system SiO_2–CaO–FeO. B. P. SELIVANOV AND V. M. SHPEIZMAN. *Metallurg*, **13** [2] 26 (1938).—Four groups of slags were used: (1) SiO_2 24 to 25, CaO 0 to 40%, the remainder Fe oxides; (2) SiO_2 30, CaO 0 to 50%, the remainder Fe oxides; (3) SiO_2 40, CaO 0 to 35%, the remainder Fe oxides; and (4) SiO_2 50, CaO 0 to 35%, the remainder Fe oxides. The sum of CaO + FeO was constant in each group. Two heat-content measurements were made below, two above, and one at the melting point. At temperatures up to the melting point, the heat content of slags changes very little. With increase of CaO up to 20%, in the last three groups the heat content drops slightly, but a further increase of CaO from 20 to 50% causes a rise in the heat content. This was not observed in slags of the first group. Above the melting point, the heat contents of various slags are identical because of their differing tendency to crystallize. All the slags consisted of crystalline and vitreous parts. If the chemical composition of the slag is almost the same as that of an easily crystallizing chemical compound, the heat content increases with a rise in temperature. Slags that do not have this chemical composition but crystallize easily will have the same or a slightly lower heat content as the temperature rises. This phenomenon is due to the varying proportions of crystalline and vitreous components in the slag. The heat content is not an additive function, but it depends a great deal on the mineralogical composition. See "Viscosity—," *Ceram. Abs.*, **17** [11] 366 (1938). B.Z.K.

Influence of fluorides on the spectral absorption of colored iron complexes. W. WEYL AND H. RUDOW. *Z. Anorg. & Allgem. Chem.*, **226**, 341–49 (1936).—The effect of fluorine on many iron salts is the formation of the colorless complex FeF_6, which diminishes the intensity of coloration of the iron salt. The absorption bands are broadened by fluorine addition and migrate toward the shorter wave lengths. The effect is less at higher temperatures. H_3BO_3 neutralizes the effect of fluorine. E.P.

Influence of temperature on the dielectric properties of TiO_2 and ZnO_2. C. SCHUSTERIUS. *Z. Tech. Physik*, **16** [12] 640–42 (1935).—The dielectric constants of pure and somewhat reduced rutile and zinc oxide were determined approximately between room temperature and 570°F. The addition of impurities causes a considerable variation in the dielectric constants. Mixed crystals of TiO_2 and ZnO_2 show a continuous change of dielectric data. W.M.C.

Meaning and standardization of the p_H scale. D. A. MACINNES, DONALD BELCHER, AND THEODORE SHEDLOVSKY. *Jour. Amer. Chem. Soc.*, **60** [5] 1094–99 (1938).—Illustrated. F.G.H.

Method of "differential regression" in analysis of variance. W. A. HENDRICKS. *Jour. Agr. Sci.*, **27** [2] 188–90 (1937).—H. discusses and illustrates the importance of making due allowance for sampling errors in the regression coefficients involved in the application of covariance analysis to experimental data. P.S.D.

Microscopical determination of potassium with naphthol yellow S. HAROLD A. FREDIANI. *Ind. Eng. Chem., Anal. Ed.*, **10** [8] 447–49 (1938).—Potassium may be determined qualitatively in the presence of ammonium by means of naphthol yellow S. Ammonium, cesium, lithium, magnesium, and sodium ions do not react with the reagent to form insoluble crystalline salts. Cupric, lead, rubidium, and silver ions form precipitates and may mask the microscopical test for potassium. Illustrated. F.G.H.

Nature of glass phase in heated clay materials: II, Effect of rate of heating on the glass phase and physical properties of whiteware bodies. GEORGE R. SHELTON AND WILLIAM W. MEYER. *Jour. Amer. Ceram. Soc.*, **21** [11] 371–85 (1938); for Part I see *ibid.*, **18** [10] 289–96 (1935).

Phase equilibria studies on mixtures of the compounds $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$–$2CaO \cdot Fe_2O_3$–$K_2O \cdot Al_2O_3$. WILLIAM C. TAYLOR. *Jour. Research Nat. Bur. Standards*, **21** [3] 315–25 (1938); R.P. 1131. Price 5¢.—A portion of the system CaO–Al_2O_3–Fe_2O_3–K_2O has been investigated. Phase equilibria were studied by the quenching method. No ternary compounds containing K_2O were observed. The compounds $K_2O \cdot Al_2O_3$ and $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ were found to form a binary system with one eutectic. Since it was observed that, for a given ratio of $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ to $2CaO \cdot Fe_2O_3$, the solid solution of these two compounds and $K_2O \cdot Al_2O_3$ resembled a binary system with a single eutectic, these compounds are considered as forming a pseudobinary system. Pertinent optical and thermal data are presented. Temperature-concentration dia-

grams for sections of the quaternary system are constructed. R.A.H.

Physical chemistry of metal slag reactions. FRIEDRICH KÖRBER. *Z. Elektrochem.*, **43** [7] 450–60 (1937).—K. discusses three general methods of investigation: (1) taking samples from large-scale technical operations, (2) conducting laboratory experiments on simple systems to discover general principles, and (3) applying thermal data to calculate equilibria when available. He shows, with numerous examples, how the second and third methods have been followed by the Kaiser Wilhelm Institute. E.J.V.

Precipitation of calcium in the presence of ammonium molybdate and iron. R. C. WILEY AND ALEC YEDINAK. *Ind. Eng. Chem., Anal. Ed.*, **10** [6] 322–23 (1938).—Both calcium and phosphorus are determined on the same charge. Calcium may be accurately determined by precipitating it as the oxalate and titrating with potassium permanganate after removing the phosphorus as ammonium phosphomolybdate. Moderate amounts of iron do not interfere. Ammonium molybdate does not interfere with the quantitative precipitation of calcium in the presence of a moderate amount of acetic acid and ammonium oxalate. F.G.H.

Proximate analysis of organic constituents in soils. J. M. SHEWAN. *Jour. Agr. Sci.*, **28** [2] 324–40 (1938).—Waksman's system of proximate analysis, with various modifications for greater accuracy, is described. Results obtained on several soil profiles with this method are recorded and discussed. P.S.D.

Quantum statistical theory of fusion. L. TARSCHISCH. *Z. Physik*, **99** [3–4] 259–73 (1936).—From the Debye theory of specific heats and the crystal dynamics of Born, T. deduces a melting theory. Mathematical. E.P.

Rapid potentiometric method for determination of sulfate. B. E. CHRISTENSEN, HERBERT WYMORE, AND VERNON H. CHELDELIN. *Ind. Eng. Chem., Anal. Ed.*, **10** [8] 413–14 (1938).—Illustrated. F.G.H.

Rapid subsieve size determination of pulverized minerals. C. E. HEINZ. *Rock Products*, **39** [11] 50–52 (1936).—H. describes charts which facilitate the calculation of sedimentation data obtained by use of Bouyoucos hydrometers. The special nomograph constructed to correct time-factor readings of the Bouyoucos hydrometer when solids are dispersed in water combines the factors of the specific gravity of the mineral being investigated and the working temperature. H. shows how charts can be made for minerals having unusual characteristics and for special grinding and sizing operations or unusual plant conditions. E.J.V.

Reactions in the solid state at high temperatures: XIV, Intermediate state in the formation of zinc aluminate from zinc oxide and aluminum oxide in the solid state. W. JANDER AND K. BUNDE. *Z. Anorg. & Allgem. Chem.*, **231**, 345–64 (1937).—Interaction of solid ZnO and Al_2O_3 between 400° and 1200° was studied by the following methods: X-ray, catalytic action on a $2CO+O_2$ mixture, sorptive power for different dyes, and solubility in ammonium chloride, hydrochloric, and sulfuric acids. The surface reaction which is the beginning of interaction causes the formation of defective crystals which, on aging, transform into perfect crystals. For Part **XIII** see *Ceram. Abs.*, **15** [8] 259 (1936); for Part **XII** see *ibid.*, **17** [3] 120 (1938). E.P.

Solid solutions of calcium ferrite in monoaluminate of calcium produced by means of sintering. D. S. BELYANKIN, N. A. TOROPOV, AND T. M. DUKO. *Vsesoyuz. Nauch.-Issled. Inst. Tsementov*, No. 18, pp. 57–74 (1937).—A partial replacement of alumina in a monoaluminous mix by iron tends to form solid solutions of $CaO \cdot Fe_2O_3$ and $CaO \cdot Al_2O_3$ of varied concentration, depending on the Fe_2O_3 content of the mix, the temperature, and the duration of firing. M.V.C.

Solubility of lithium and sodium fluorides. JOHN H. PAYNE. *Jour. Amer. Chem. Soc.*, **59** [5] 947 (1937). F.G.H.

Stabilization of kaolin suspensions by soluble phosphates. E. M. NATANSON. *Ukraïn. Akad. Nauk, Zapiski Inst. Khem.*, **5** [2] 165 (1938).—The dispersion of Glukhovetskiĭ kaolin suspensions was determined by means of a sedimentometer. The addition of Na_2SiO_3, Na_2CO_3, and Na_2HPO_4 increased the stability and dispersion of the kaolin suspensions. Their effects upon the stability may be expressed in the following order: $Na_2CO_3 < Na_2SiO_3 < Na_2HPO_4$. Maximum stabilization is produced when the Na_2HPO_4 concentration is low (up to 15 millimoles). At higher concentrations the stability drops. B.Z.K.

Ternary system selenium dioxide–barium selenite–water at 0°, 25°, and 50°C. JOSEPH L. NEAL, JR., AND C. R. MCCROSKY. *Jour. Amer. Chem. Soc.*, **60** [4] 911–14 (1938).—Data on the solid-solution equilibrium were obtained for the ternary system selenium dioxide–barium selenite–water at 0°, 25°, and 50°C. At each temperature, the stable solid phases prove to be selenious acid, H_2SeO_3, barium pyroselenite, $BaSe_2O_5$, and barium selenite, $BaSeO_3$, all of which have long been known. No indication of unknown acid salts or hydrates was found within the temperature range studied. The normal salt monohydrate, $BaSeO_3 \cdot H_2O$, reported by Nilson can not be confirmed. Illustrated. F.G.H.

Three-compound system, $RO–R_2O_3–SiO_2$. JOSEF WOLF. *Sprechsaal*, **71** [11] 137–39; [12] 149–51; [13] 162–64; [14] 172–73; [15] 183–85; [16] 197–99 (1938).—Tables of the characteristics of the $RO–R_2O_3–SiO_2$ system are analyzed in detail. M.V.C.

Transition α to β quartz. HELMUT ERNST VON STEINWEHR. *Naturwissenschaften*, **25**, 348 (1937); *Chem. Abs.*, **31**, 8333 (1937).—Photographic time curves of temperature, double refraction, and circular polarization were made during the transition of α to β quartz. Three distinct steps in double refraction and polarization are found (U_1, U_2, and U_3, thermal stops). For slow temperature rise (more than 30 min./°) the corresponding temperature intervals are 0.1° for U_1 to U_2 and 0.7° for U_2 to U_3. It is assumed that the intermediary states U_1 to U_2 and U_2 to U_3 represent definite reversibly attainable modifications; one of them has double refraction along the c axis.

Use of a palladium tube in gas analysis. A. G. FLEIGER. *Ind. Eng. Chem., Anal. Ed.*, **10** [9] 544–47 (1938).—F. describes a method of analysis for gas mixtures which consist largely of hydrogen and small amounts of carbon monoxide, nitrogen, methane, and higher hydrocarbons. The higher molecular hydrocarbons are frozen at −180°C. and the hydrogen is removed by diffusion through a palladium tube at 300°C. The carbon monoxide and methane are then burned over cupric oxide at 250° and 800°C, respectively, and the products of combustion are frozen at −180°C. The residue of the gas is nitrogen. A study has been made of the limitation of the use of a palladium tube in the analysis of gases containing relatively large amounts of hydrogen and small amounts of carbon monoxide and methane. Illustrated. F.G.H.

X-ray study of the systems $CaO–Al_2O_3$ and $SrO–Al_2O_3$. K. LAGERQVIST, S. WALLMARK, AND A. WESTGREN. *Z. Anorg. & Allgem. Chem.*, **234**, 1–16 (1937).—Five compounds were found in the $CaO–Al_2O_3$ system and four in the $SrO–Al_2O_3$ system which were analogous to the lime compounds. The degrees of symmetry and lattice dimensions are reported. E.P.

BOOKS AND SEPARATE PUBLICATIONS

Calculations in Quantitative Chemical Analysis. JOHN A. WILKINSON. McGraw-Hill Book Co., Inc., New York, 1938. 2d ed. 154 pp. Price $1.75. Reviewed in *Jour. Amer. Chem. Soc.*, **60** [6] 1516 (1938). F.G.H.

PATENTS

Granular nonvitreous desiccated borax. T. M. CRAMER AND G. A. CONNELL (Pacific Coast Borax Co.). U. S. 2,131,793, Oct. 4, 1938 (July 23, 1928).

Making alkali chromate. SILESIA, VEREIN CHEMISCHER FABRIKEN. Ger. 657,016, Feb. 10, 1938 (April 22, 1936); IV*b*/12*m*. 8; addition to Ger. 599,299. Molded

material consisting of chromium ore, aluminum carbonate, and basic admixtures is oxidized by firing. The oxidation is brought about in an externally heated slag furnace. D.A.B.

Method of making cadmium red. W. F. MEISTER (Interchemical Corp.). U. S. 2,134,055, Oct. 25, 1938 (Jan. 31, 1938). The process of making cadmium red comprises calcining in a neutral atmosphere cadmium thioselenide in admixture with a number of molecules of cadmium oxide less than one-half the number of atoms of selenium contained in the cadmium thioselenide.

Production of crystal soda ($Na_2CO_3 \cdot 7H_2O$) in lump state. SOLVAY & CIE. Ger. 662,091, June 9, 1938 (July 21, 1934); IV*b*/12*l*. 15. A quantity of $Na_2CO_3 \cdot 10H_2O$, in the presence of an addition of other material, is kept at a temperature of 32° to 35° until a rather thick mass is obtained whose solid phase consists essentially of $Na_2CO_3 \cdot 7H_2O$. After transformation into lumps, the mass is gradually cooled below 32°C. D.A.B.

Purification of alkali-metal hydroxides. H. M. SPITTLE (Imperial Chemical Industries, Ltd.). U. S. 2,132,585, Oct. 11, 1938 (May 20, 1937). In the purification of caustic alkali solutions containing silica, the process comprises subjecting such solutions, in contact with substantial amounts of a material selected from the group consisting of alkaline-earth metal oxides, hydroxides, and salts, to the action of an added ferric compound, the ferric compound being present in sufficient amount to provide a molecular ratio of ferric iron, calculated as Fe_2O_3, to the silica greatly in excess of 1:1, and removing the precipitate formed.

Stable hydrous silicate and method of making. G. R. MCDANIEL (Diamond Alkali Co.). U. S. 2,131,718, Sept. 27, 1938 (July 2, 1936). A method of preparing a stable crystalline hydrous sodium silicate comprises preparing a liquor comprised of substantially 1.75 to 2.25 molecular parts of sodium oxide to each one molecular part of silicon dioxide and containing an amount of water sufficient to produce a hydrate and to permit of crystallization of substantially all of the liquor and then elevating the temperature of such liquor to a degree sufficiently high to transpose the liquor to solid crystallitic state, with substantially no evaporation of water.

General

Brick and tile industry in South Africa. G. C. MATTHEWS. *Brit. Clayworker*, **47** [555] 133–34 (1938).—Common and refractory brickworks at or near Cape Town, Johannesburg, and Vereeniging, South Africa, are briefly described. R.A.H.

Determination of composition of dusts according to grain size and fall velocity. H. W. GONELL. *Z. Ver. Deut. Ing.*, **80** [21] 646–47 (1936).—Dusts with grain sizes below 60 μ are determined by sedimentation or sorting by wind, and those above 60 μ grain size, by sifting. Curves of fall velocity were calculated for Portland cement and coal dust. M.H.

Experiences with the use of amorphous silica. J. S. LAMBIE. *Ind. Med.*, **7** [8] 470–72 (1938).—L. states that the form of silica presenting an industrial hazard in the Fisher Body Division is tripoli. It is the main ingredient of the paste used to put the final high-luster polish on automobile bodies. Supplies of the raw material come from southwestern Mo. and must be excavated, ground, and screened before using, processes which are all productive of dust. Tripoli is an amorphous silica, originally deposited in primeval sea water from the siliceous remains of diatoms. After long subjection to the action of percolating waters, a soft, friable, porous form of silica was left, which has a 97% content of SiO_2 and fractional percentages of iron, aluminum, and lime. The use of tripoli for polishing cars dates from 1930. L. describes the method of its application. In December, 1936, the first dust count was taken with a small portable dust counter; seven counts were taken, the average of dust particles being 56 million/cu. ft. The particle average in finely pulverized tripoli was between 4 and 5 microns, and the amount of SiO_2 in the dust was about 40%. Later studies with the Greenburg-Smith impinger showed an average dust count of 2 million particles /cu. ft. Men exposed to the tripoli dust were reluctant to use respirators, but 89 men engaged in wheel-polishing with tripoli were willing to have X-ray films made of their chests; 25 had been exposed to this dust approximately 7 or 8 years, 1 for 6 years, 18 for 3 years, 30 for 2 years, and 12 for 1 year or less. In no case could a frank diagnosis of silicosis be made, and no tuberculosis was found. The entire personnel of 3000 workers in the plant was tested for tuberculosis. L. discusses the difficulties inherent in the diagnosis of first-stage or early silicosis, especially from such short exposure periods. Statistics on 18 wheel-polishers who had been working with tripoli 7 years are given, their respiratory indexes having been determined; only two fell below the average (20 for normal persons). L. describes the precautionary, protective follow-up program now operating in the plant. K.R.

Fight against silicosis in the metal industry. ANON. *Oberflächentech.*, **15** [18] 180–81 (1938).—Silicosis develops in men sandblasting or grinding metals more rapidly than in miners. Means for preventing inhalation of the fine metal dust, adequate equipment, and clinical aspects are briefly discussed. Grinding wheels of artificial stone are much more sanitary, as the dust does not contain any free SiO_2 which is the main cause of silicosis. Wherever possible, artificial stones should be used. M.H.

Handling system in stove plant raises efficiency and reduces costs. R. L. HARTFORD. *Steel*, **101** [20] 57–58, 96 (1937).—A very old stove plant was rehabilitated by the installation of a modern materials handling system. It consists of a combination of overhead chain conveyers, gravity rolls, belts, skids, and trucks, requiring extensive alterations in the walls, floors, and partitions of the old plant. Where dozens of handlings from raw material to finished product were formerly required, only two or three handlings are now necessary. Illustrated. H.E.S.

Harmful industrial dusts. R. R. SAYERS. *U. S. Pub. Health Repts.*, **53** [6] 217–27 (1938).—This article, representing 37 expert researches and S.'s expert selective judgment in the organization of comprehensive material, set forth in clear and simple style, is an authoritative document. As an engineering problem, dust control has evidently proceeded far toward dust suppression, dealing with it at the point of origin. Enough practicable measures are suggested from accumulated experience and resourcefulness to run the whole gamut of the dusts described. Stress is laid on periodic examinations of workers, intended to secure and maintain physical fitness and thereby lengthen work spans. The basic principle of physical examinations in industry is to keep men on the job and not to allow the physical examination to be merely a weeding-out process. K.R.

Improvement of ceramic bodies: I. FELIX SINGER. *Brit. Clayworker*, **47** [555] 113–15 (1938).—S. discusses the addition of barium carbonate to ceramic bodies and the advantage of adding it as a watery suspension with such materials as bentonite, ball clay, and other clay minerals. The solubility of the carbonate may be further increased by the addition of humic acid materials. **II.** *Ibid.*, [556] 149–51.—The casting of refractory blocks and shapes is discussed, and much emphasis is given to British Patent 6560 (1909) granted to Emil Weber for the "Process for making slips from clay, porcelain earth, and the like or mixtures thereof." R.A.H.

Industrial health impairment from aluminum, especially its dust. M. DOESE. *Arch. Gewerbepath. & Gewerbehyg.*, **8**, 501–31 (1938).—A comprehensive and thorough in-

vestigation of aluminum dust as a possible respiratory hazard resulted from the appearance in 1934 at the Occupational Disease Clinic, Berlin, of a patient who had been spraying aluminum bronze for nearly a year and who showed signs of a lung disease of a not very clear character. Early in 1934 an Italian doctor of the throat and nose clinic at the University of Rome published his observations upon the effect of aluminum dust on the air passages. The present research includes (1) the components and properties of the substance (which does not occur in nature in metallic form but is the result of mechanical and chemical processes), (2) 30 citations of previous studies on the injurious effects derived from the preparation of aluminum and its industrial uses, (3) the detailed case-history of the patient, with laboratory findings and Roentgen studies, (4) an intensive investigation of 70 workers in aluminum works, and (5) a critical analysis of the Italian data. The hazards were found to be completely negative, both in the processes of making aluminum and from inhalation of the dust. K.R.

Inhalation of dust and control of dust hazards. W. C. JAMES. *Concrete, Cement Mill Ed.*, **46**, 200–201, 216–17 (1938).—Many persons inhale excessive dust into their lungs, with coal and iron-ore dust coloring the lung tissue. In most cases, however, these changes are of no more importance than callouses on the hands. Only two dusts actually cause diseases on inhalation, silicon dioxide (usually quartz) and asbestos. Only particles below 10 μ are effective, and these must be breathed in high concentration and over a long period of time. A safe maximum concentration is 5 million particles of quartz dust per cu. ft. The exposure of each man should be reduced to particle-hours to be comparable. The length of time necessary to develop silicosis is controlled by (1) concentration of dust, (2) proportion of free silica, (3) length of exposure, and (4) general health of the employee. It is unusual to have silicosis develop in less than seven years. Dust should be removed at the source. W.D.F.

Occupational diseases of the lungs in agricultural workers. RICHARD FAWCITT. *Brit. Jour. Radiol.*, **11**, 378–92 (June, 1938).—In 1936, 749,700 persons were employed in the agriculture of Great Britain, forming one of the largest working groups. F., as a country practitioner in the hills of the Lake District, early became familiar with the agricultural types of asthma, bronchitis, and pneumonia which usually ran a protracted course among these workers; recovery, when occurring, appeared largely due to potassium iodide and creosote administration. The infections the working people are subject to are listed as organic matter (microfungi and bacteria) existing in grasses, straw, grain, fruits, the soil, and in the excreta of farm animals; only occasionally does inorganic matter affect them, *e.g.*, men carting siliceous stones. The details of fungi infection and the procedure in identification are briefly and clearly given; types of fungi predominantly affecting six special groups of farm hands, *e.g.*, hay or grain workers, stablemen, gardeners, etc., are described, with the resulting symptoms and injury. Nine points to be considered in a doctor's study of such cases are systematically presented for case-history record. Special comment is made upon the agricultural groups, with citations from case reports; 13 large-size radiographic reproductions of chest phenomena in the various fungi invasions concerned are interpreted for the lay reader. F. emphasizes these occupational diseases as rare, seldom reaching radiological departments or diagnosis. Yet common microfungi, often innocuous, do become pathogenic under certain conditions. The incidence of harmful infection is more common and more widespread than is generally realized. 19 references. K.R.

Practical significance of silicate research. A. DIETZEL. *Glastech. Ber.*, **14** [5] 161–64 (1936). J.F.H.

Prevention of disease in industry. D. HUNTER. *Ind. Chemist*, **13**, 134–36 (1937).—The main principles underlying the prevention of disease in industry are (1) protection of workmen by law such as workmen's compensation acts, (2) medical inspection under state support, (3) education as to the nature of the danger, (4) importance of cleanliness (cleanliness of work places, bodily cleanliness, and general hygiene), and (5) reduction of manual operations. H.E.S.

Preventive measures in the use of crystalline silica. M. M. SHAFER. *Ind. Med.*, **7** [8] 472–75 (1938).—S. presents the subject systematically under three major aspects: (*A*) medical, (*B*) engineering, and (*C*) managerial. He suggests that, before any protective measures in the use of crystalline silica are resorted to, the fact be established that a silica hazard exists. Data involved include (1) a definite exposure to dust known to contain a certain percentage of silica and (2) sufficient dust exposure, as estimated by dust count and dust composition, to cause silicosis if the exposure is continued over a sufficiently long period of time. In emphasizing (*B*), S. states that it is entirely the problem of the engineer to prevent silicosis. The medical director can only check the adequacy of the engineer's methods of control. K.R.

Recovery metabolism of silicotics. A. BÖHME. *Arch. Gewerbepath. & Gewerbehyg.*, **8**, 601–10 (1938).—B. records the metabolism studies and muscular tests applied to silicotics in varying stages of the disease to improve their greatly impaired respiratory capacity and muscular action, if possible, and at least to record the success or failure of such efforts. Tables show a comparison of the metabolism of normal persons after 15 bendings of the knees (as in climbing stairs), after taking food, and after rest with the metabolism of the silicotics (four having a lessened industrial capacity of 80% and six lessened to 50 or 60% capacity). Items tabulated include age and vital capacity after food and after rest; respiration, minute volume, and O_2 requirement; the respiratory quotient, conversion rise in %, and these values after rest; and the O_2 needs (cc./min.). In the severest forms of silicosis, the total variation in the 10-min. recovery periods was higher than the highest shown in normal persons. Acid absorption had not returned to normal after 10 min., while in normal persons it was completed in 3 or, at most, 6 min. The minute values of respiration in the most severely ill subjects was markedly raised after the work attempted, and even after the 10 min. rest, it did not attain its previous value. The higher the lessened capacity for work in percentage value, the more the records varied in severe silicosis. Experiments on early or middle-period silicotics showed fewer certain, unmistakable results, their working capacity being still much higher. K.R.

Research laboratories of Mellon Institute. HARRY S. COLEMAN. *Ind. Eng. Chem., Anal. Ed.*, **10** [9] 550–58 (1938).—The design, construction, and equipment of the research laboratories in the new Mellon Institute building are described in detail. Illustrated. F.G.H.

Research laboratory of the Columbia Chemical Division of the Pittsburgh Plate Glass Co. ANON. *Ind. Eng. Chem., Anal. Ed.*, **10** [6] 329–30 (1938).—The physical equipment is briefly described. Illustrated. F.G.H.

Safety and hygiene in the foundry: I, Medical aspects. R. R. JONES. *Trans. Amer. Foundrymen's Assn.*, **8** [2] 554–64 (1937).—The more important industrial health problems associated with the foundry industry are those related to (*a*) general physical characteristics of the building, (*b*) housekeeping practices, (*c*) drinking water supply and lunchroom and toilet facilities, (*d*) exposure to extreme temperatures, (*e*) exposure to toxic or irritating dust, fumes, and gases, and (*f*) medical supervision. Success in the control of industrial health hazards is primarily dependent upon the employer's attitude toward the problem. **Discussion.** J. A. BRITTON ET AL. *Ibid.*, pp. 576–88. H.E.S.

Hermann August Seger. ANON. *Bull. Amer. Ceram. Soc.*, **17** [11] 463–64 (1938).

Silicate research and engineering. W. EITEL. *Z. Ver. Deut. Ing.*, **80** [2] 37–41 (1936).—The conditions and status of silicate research as carried out in the Kaiser Wilhelm Institute in Berlin with regard to glass, ceramics, cements, mortars, and concrete and the relation to application in practical engineering are explained. M.H.

Silicosis among grinders. J. L. A. GROUT. *Brit. Jour. Radiol.*, **11**, 366–70 (June, 1938).—This interesting

sketch of the work of Sheffield grinders in sharpening knives, forks, and needles and their working conditions during the 18th and 19th Centuries shows the speedy evolution of silicosis in startlingly simple but deadly form. In a typical Sheffield grinding shop the 4 to 8 sandstones, giving off in every process almost pure silica dust in varying grades of fineness, wore down steadily in 4 to 6 weeks, when fresh sandstones were brought in to continue wearing down the workers as well as the stones. In 1834 "dry grinders" of forks were dying off between the ages of 28 and 32, while knife grinders, who used wet processes, often lasted until 50. In 1822, out of 2500 grinders, not 35 had lived to be 50; of 80 fork grinders, exclusive of boys, not a single worker of 36 years of age was alive. G. sets forth the efforts made from time to time to alleviate these fatal conditions. In 1822, a magnetic respirator proved effective but never became popular, the workers themselves rejecting it for fear the lessened risk of their labor would lower their wages. In 1834, Dr. Knight of Sheffield developed in the *North of England Medical Journal* what would now be termed a 5-point program of dust control, including the following measures which are now taken for granted in almost every dusty workplace: (1) dusting the machinery before work commences; (2) great reduction in working hours when exposed to dust; (3) use of wet stones as much as possible; (4) large flues for ventilation laid in the floors, with currents of air forced through them by the machinery; (5) fork grinding to be performed by criminals (a proviso probably not carried out, any more than the rest of the program). G. describes and illustrates the customary Sheffield grinding shop and the processes carried on there which have remained much the same for generations of workers until quite recently. Radiological representations corresponding to the 3 stages of silicosis rapidly passed through under these all too favoring conditions are compactly given. During the last few years the sandstones have been gradually replaced, in all but a few shops in Sheffield, by so-called artificial stones without a silica content. Under the Factory Act of 1925 the X-ray examinations of grinders of less than 20 years standing have proved negative for silicosis in a majority of cases. K.R.

Silicosis and similar dust diseases. R. R. Sayers and R. R. Jones. *U. S. Pub. Health Repts.*, **53** [33] 1453–72 (1938).—Silicosis is only one of many pneumonoconioses, but since more workers in industrial dusts are exposed to air containing particles of silica (SiO_2) and the resulting disabilities are far more disastrous than those from exposure to any other dangerous industrial dust, the authors summarize the knowledge concerning the cause and prevention of silicosis. Since silica is the most abundant constituent of the earth's crust, whether as free silica (SiO_2) or as silica compounds, occupations such as tunnel-driving, highway development, mining, etc., frequently have a silica hazard. The industrial uses of silica are tabulated for ready reference, together with the types or forms involved. In the pottery industry silica is used as an ingredient of bodies and glazes. Types of silica utilized in ceramic processes are flint, chert, silica, tripoli, and other pure silica forms, finely ground. Rough but probably conservative estimates show that at least 500,000 workers in the U. S. are exposed to silica dust to a harmful degree. The factors influencing the action of industrial dusts (size-frequency distribution and group-size in microns) are tabulated. A graph shows the velocity of fall for various kinds of dust, *i.e.*, the rapidity of settling for a given dust in relation to the size and density of particles. Silicosis literature shows 26 countries reporting silicosis; all races appear equally affected or susceptible, and no nationality is exempt. Predisposing causes, the effects of other dusts mixed with silica dusts, and anthracosilicosis receive separate attention. The program of silicosis prevention based on all phases of clinical and industrial experience is presented. 32 references. K.R.

Tests of respiratory efficiency and their correlation with radiological appearances in the lungs. Esther M. Killick. *Brit. Jour. Radiol.*, **11**, 401–404 (June, 1938).—K. details the tests in use in the Univ. of Birmingham Dept. of Industrial Hygiene for determining industrial fitness, first pointing out their likeness to the Moncrieff series published in 1934. The available tests measure (1) the vital capacity of the lungs, (2) the ventilation equivalent for oxygen, and (3) volume of dead space. Mercury U-tube tests (exercise tolerance tests) are also made. These estimates are applied in seven cases of asbestosis and silicosis where age, duration of exposure, and diagnosis are given. Similar facts derived from the examination of 11 electric arc welders exposed to dust (mainly iron oxide) and to nitrous fumes (NO_2, 15 to 60 parts per million) are systematized, along with the X-ray reports correlated with the results of the respiratory tests. The wide variation in normal individual reactions is mentioned as among the correlation difficulties with respect to standardization of results between radiological appearances and the respiratory tests. K.R.

Welding ceramic materials, glasses, and metals. Schad. *Sprechsaal*, **71** [11] 139–40 (1938).—Ceramic materials and metals may be easily soldered together by means of suitable glasses. The thermal coefficient of expansion of these glasses is much lower (10 to 30% less) than that of the ceramic material used. The soldering may be performed over a flame or electrically. Typical examples are given. Illustrated. M.V.C.

BOOKS AND SEPARATE PUBLICATIONS

Flow of Homogeneous Fluids through Porous Media. M. Muskat. McGraw-Hill Book Co., New York, 1937. 763 pp. Price $8. Reviewed in *Soil Sci.*, **46** [2] 169–70 (1938).—The book consists of a preface, four parts, six appendixes, and author and subject indexes. The four parts deal with foundations, steady-state flow of liquids, nonsteady-state flow of liquids, and flow of gases through porous media. G.R.S.

Scientific Illustration. J. L. Ridgway. Stanford University Press, Calif., 1938. xii + 173 pp. 22 plates, 23 figs. Price $4.00, cloth. Reviewed in *Econ. Geol.*, **33** [5] 572–73 (1938).—The book is intended to aid those engaged in the preparation of scientific manuscripts that require illustrations. Special attention is given to map drawing, structure sections, and block diagrams. A brief account of the processes in reproducing illustrations is included. The appendix contains 17 tables of data for draftsmen. J.L.G.

PATENTS

Bonding of calcium silicates. N. P. Pitt and E. G. Baker. Brit. 492,565, Oct. 5, 1938 (April 1, 1937).

Colored roofing granules and method of manufacturing. Paul Teetor (Central Commercial Co.). U. S. 2,133,728, Oct. 18, 1938 (Feb. 20, 1935). Granules are covered by cementitious material consisting of an insoluble phosphate that has been fused thereon and containing color pigment interspersed therein.

Colored silicate coating. C. E. Hillers (Blue Ridge Slate Corp.). U. S. 2,129,841, Sept. 13, 1938 (March 21, 1935). The process of coating granules of refractory material comprises mixing together sodium silicate and chrome oxide to produce a roughly dispersed paint, mixing together the paint, the granules, and powdered boric acid, and heating the coated granules.

Consolidation of porous materials. J. G. Vail (Philadelphia Quartz Co.). U. S. 2,131,338, Sept. 27, 1938 (Dec. 23, 1935). In the consolidation of porous materials, the process comprises mixing a solution of sodium silicate containing not substantially less than 2 moles of silica to 1 mole of sodium oxide, with a solution of sodium aluminate, the concentrations of the solutions being adjusted to produce, upon admixture, an unstable dilute liquor, setting to a full volume alkaline gel within a period of the order of 30 min., impregnating a porous material with the unstable liquor prior to setting, and gelling the mixture *in situ*.

Production of coatings or ceramic ware. Schütte A.-G. für Tonindustrie. Brit. 493,955, Nov. 2, 1938 (Feb. 26, 1937).

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